A CAHNERS PUBLICATION INTERNATIONAL EDITION JUNE 26, 1986

EDN

IBM PC-based systems perform 3000-gate designs

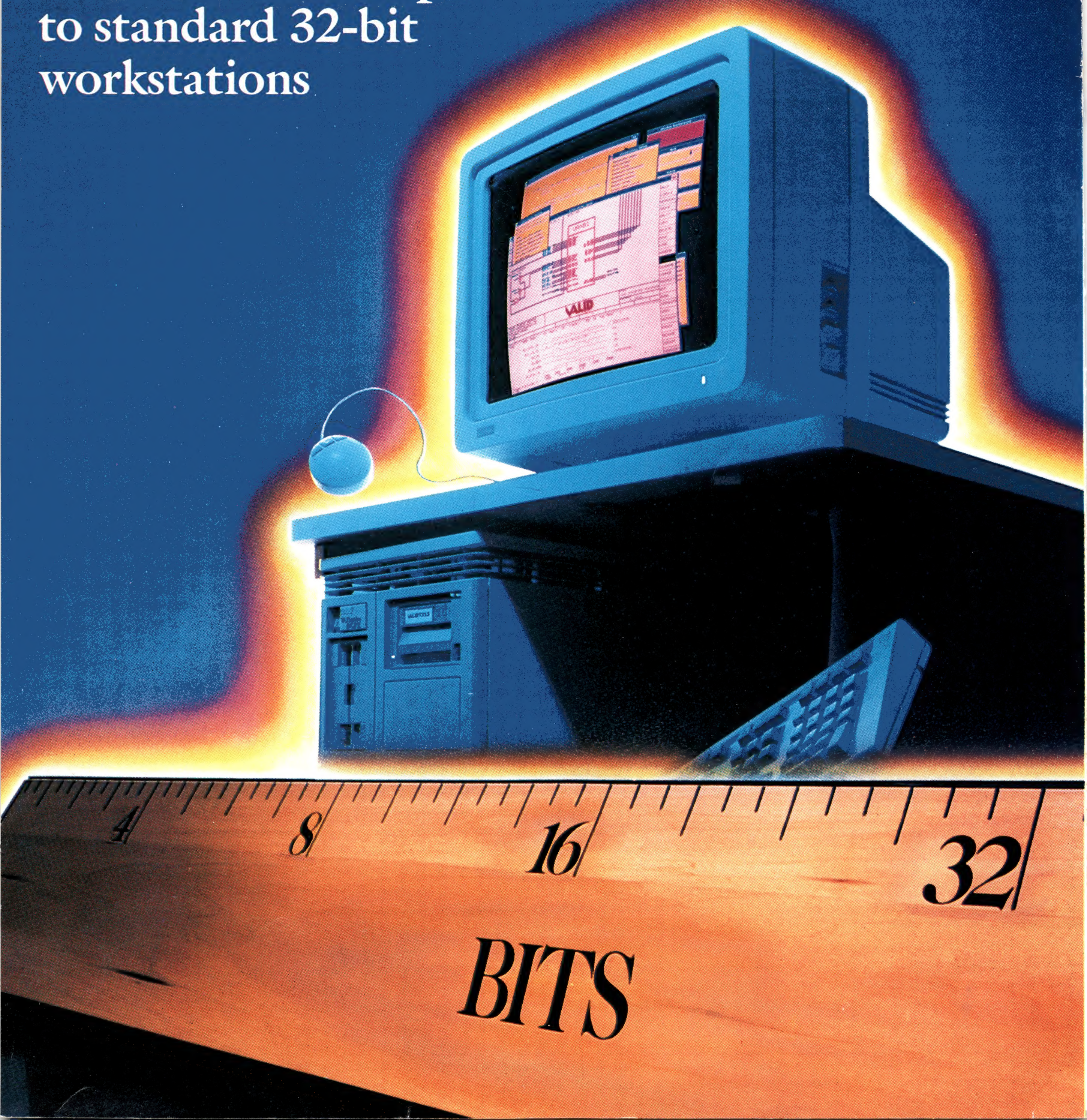
MOSFET sense cells offer lossless current measurement

Switched-capacitor ICs ease filter-circuit design

MIL-STD-1750A processors

ELECTRONIC TECHNOLOGY FOR ENGINEERS AND ENGINEERING MANAGERS

CAE software adapts to standard 32-bit workstations



lers and FIFO RAM controller are all industry exclusives. In addition, our Flow-Thru™ 16 x 16 multiplier is the industry's fastest. And our FIFO data buffering product line is the industry's broadest.

Other firsts on the way include our 16-bit ALUs. And in CMOS, our 32-bit Flow-Thru EDACs, 1K x 9 Deep FIFOs and the industry's fastest 16 x 16 multipliers.

But what's it all mean for you?

In a word, performance.

You see, even if you build your system around the best CPU and memory, it won't perform at its peak without the best suppor circuitry.

That's why you should contact us toda for our High Performance LSI Design Kit.

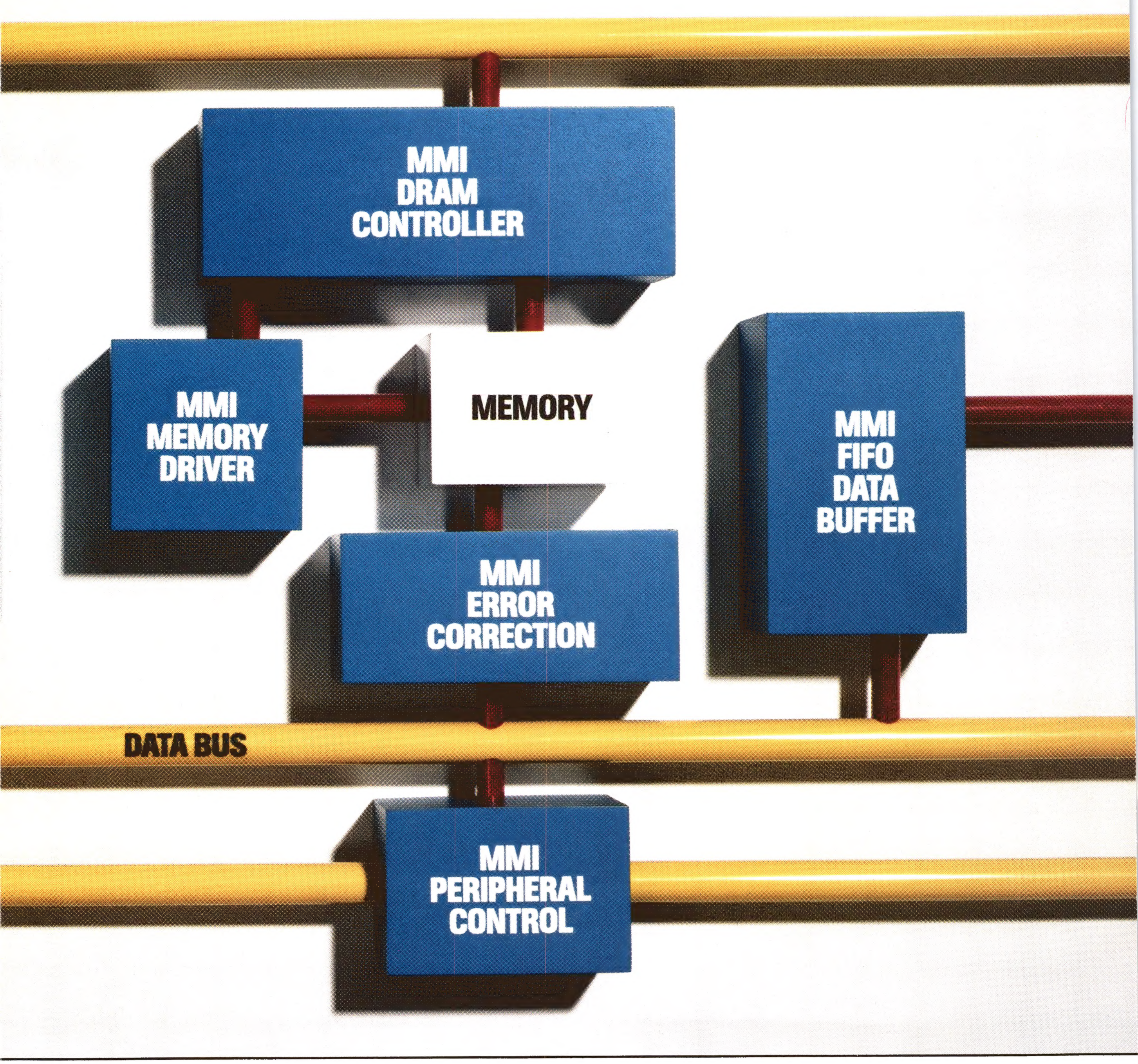
Monolithic Memories, 2175 Mission College Blvd., Santa Clara, CA 95054. (800) 247-6527, x6005.

And give your system all the support it needs.

™Flow-Thru is a trademark of Monolithic Memories, Inc. © 1986, Monoli Memories, Inc.

CIRCLE NO 170

Monolithic Memories



Just add a CPU and memory.

Building a high-performance system is now easier than ever.

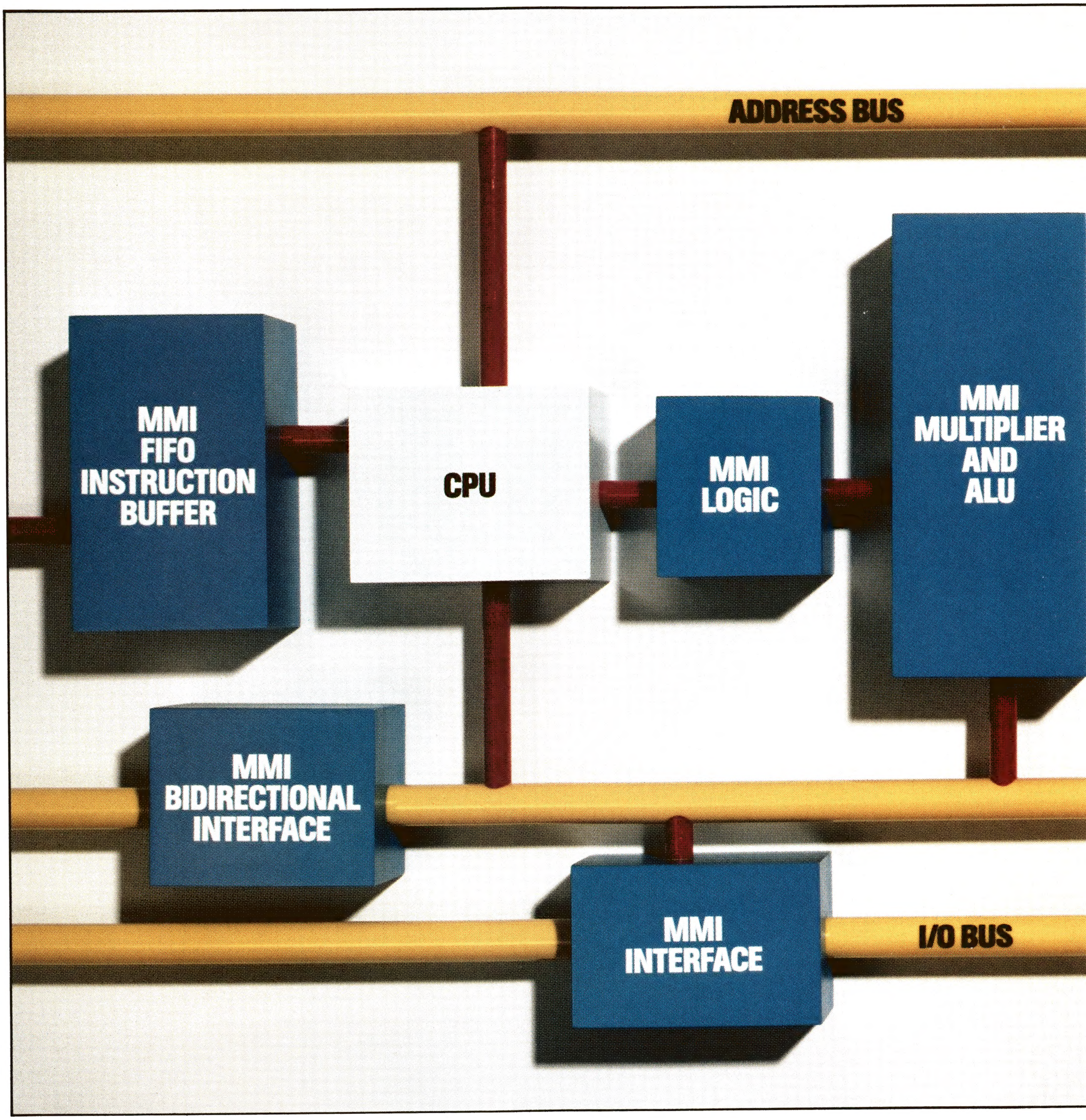
Because all the major support circuitry you'll need is available from one supplier.

Namely, Monolithic Memories.

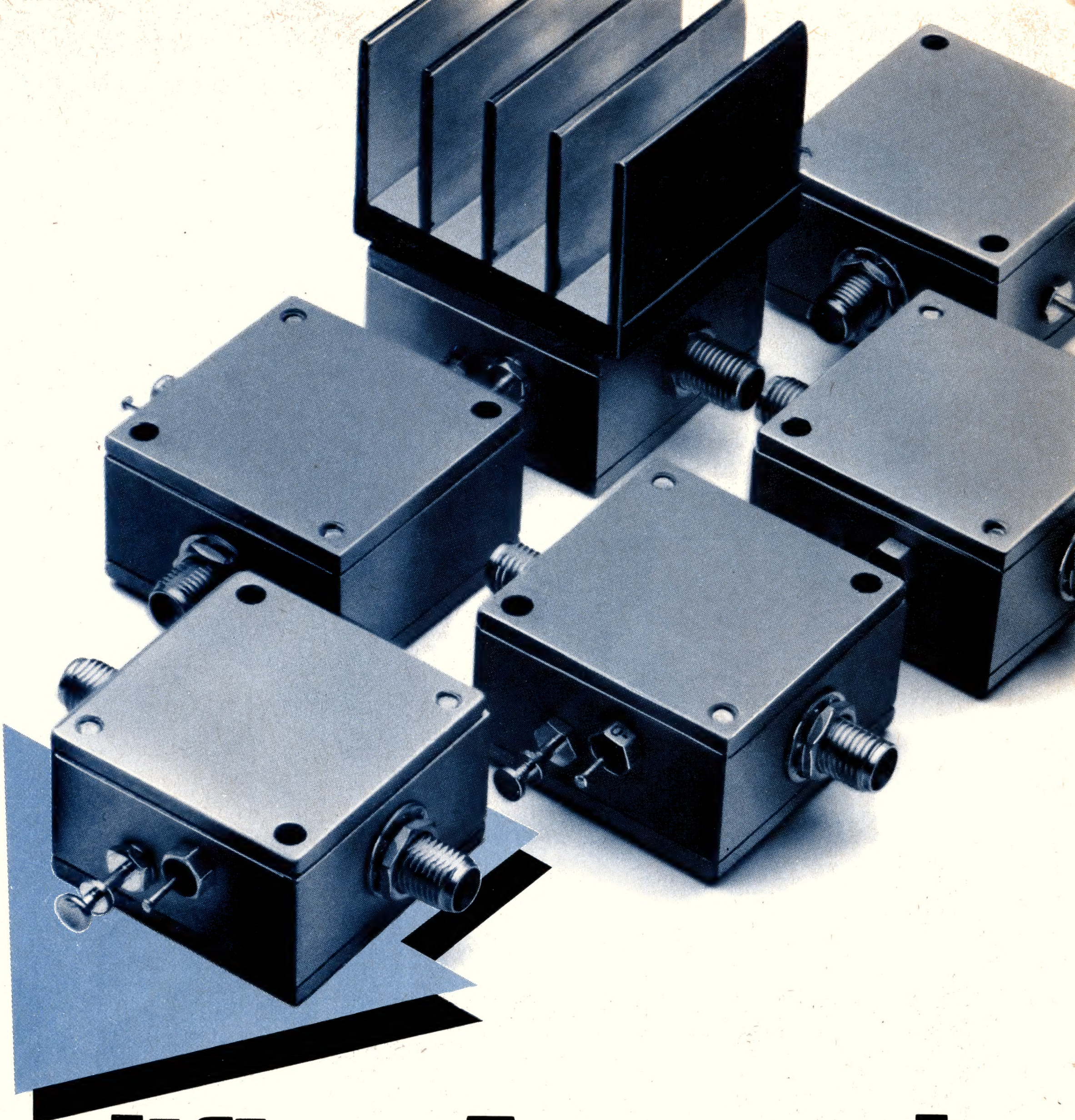
Our new high-performance LSI parts handle everything from memory support to data buffering to numerical processing. What's more, they handle it better.

Which isn't surprising when you consider that our parts perform like no others can.

For instance, our single-chip 256K DRAM controller, single-chip 1 Mbit DRAM control-



Introducing the easiest way to build a high-performance system.



Amplifier Arsenal

50KHz to 2000MHz, 100mW output Gain Controlled From **$69.95**

Our ZFL-2000 miniature wideband amplifier hit a bulls-eye when we introduced it last year. Now we've added more models to offer you a competitive edge in the continuing battle for systems improvement.

The ZFL-2000, flat from 10 to 2000MHz, delivers +17 dBm output and is still priced at only $179.

Need more output? Our ZFL-1000H, flat from 10 to 1000MHz, delivers +20 dBm output.

Variable gain important? Our ZFL-1000G, flat from 10 to 1000MHz, delivers +3 dBm output with 30 dB gain control while maintaining constant input/output impedance.

Searching for a high-quality, low-cost amplifier? Our ZFL-500 flat from 50KHz to 500MHz, delivers 10 dBm output for the unbelievably low price of only $69.

One week delivery . . . one year guarantee.

Gain the competitive edge . . . specify Mini-Circuits RF/IF signal-processing components.

SPECIFICATIONS

Model No.	**ZFL-500**	**ZFL-1000G**	**ZFL-2000**	**ZFL-1000H**
Freq (MHz)	0.05-500	10-1000	10-2000	10-1000
Gain (dB), Min.	20	17	20	28
Gain Flatness (dB) Max.	±1.0	±1.5	±1.5	±1.0
Max. Power (dBm) (1dB compression)	+10	+3	+17*	+20
NF (dB) typ.	5.3	12.0	7.0	5.0
3rd order Intercept pt (dBm)	+18	+13	+25	+33
Current at 15V dc	80mA	90mA	100mA	150mA
Price $	69.95	199	179	219
qty.	1-24	1-9	1-9	1-9

For complete specs on these and our 1- and 2-W models refer to 1985-86 Gold Book or Microwaves directory.

***+15 dBm below 1000MHz**

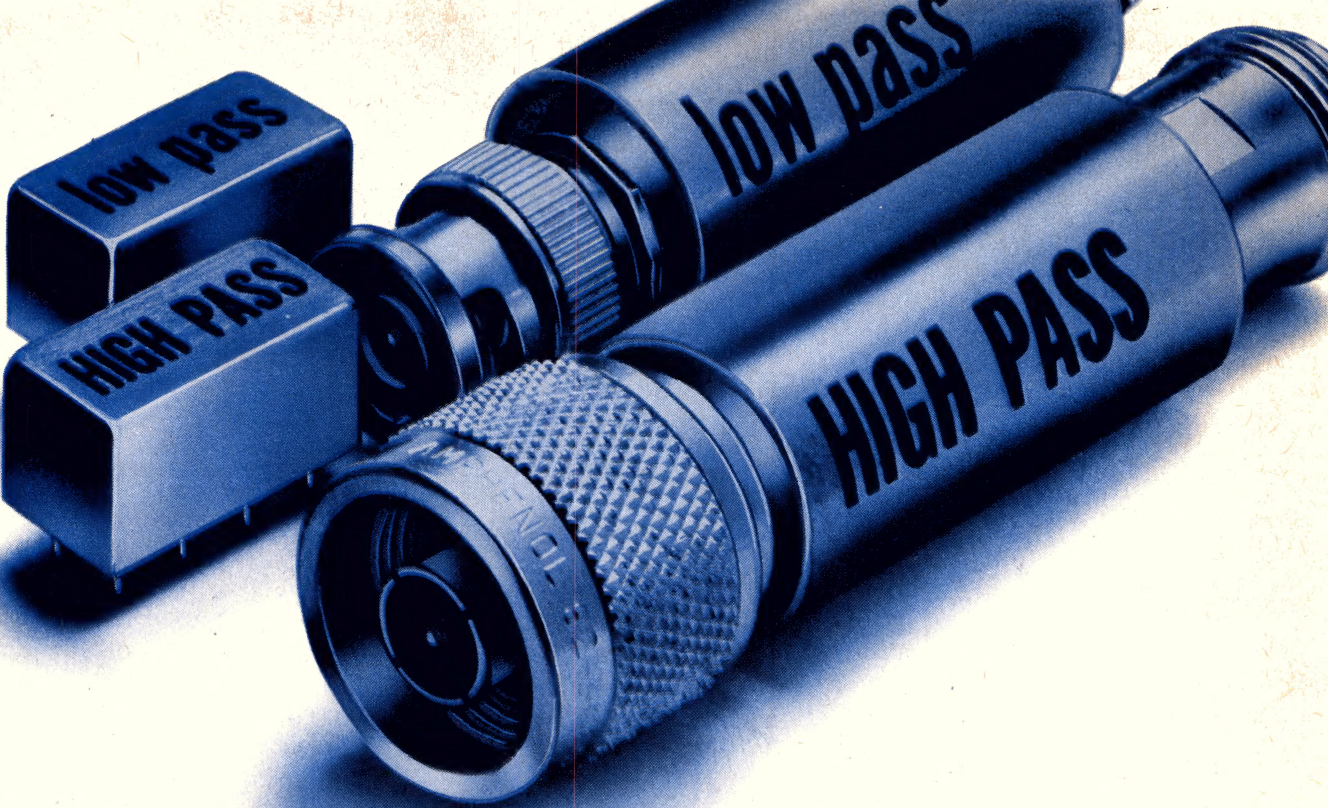
finding new ways ...
setting higher standards

Mini-Circuits

A Division of Scientific Components Corporation
P.O. Box 166, Brooklyn, New York 11235 (718) 934-4500
Domestic and International Telexes: 6852844 or 620156

CIRCLE NO 1

C101 REV. A



value-packed

filters

from $\$9^{95}$

dc to 3GHz

- less than 1dB insertion loss over entire passband
- greater than 40dB stopband rejection
- 5 section, 30dB per octave roll-off
- VSWR less than 1.7 (typ)
- over 100 models, immediate delivery
- meets MIL-STD-202
- rugged hermetically sealed package (0.4 x 0.8 x 0.4 in.)
- BNC, Type N, SMA available

finding new ways ...
setting higher standards

Mini-Circuits

A Division of Scientific Components Corporation
P.O. Box 166, Brooklyn, New York 11235 (718) 934-4500
Domestic and International Telexes: 6852844 or 620156

LOW PASS **Model** *LP–	**10.7**	**50**	**100**	**150**	**200**	**300**	**450**	**550**	**600**	**750**	**850**	**1000**
Min. Pass Band (MHz) DC to	10.7	48	98	140	190	270	400	520	580	700	780	900
Max. 20dB Stop Frequency (MHz)	19	70	147	210	290	410	580	750	840	1000	1100	1340

Prices (ea.): P $9.95 (6-49), B $24.95 (1-49), N $27.95 (1-49), S $26.95 (1-49)

HIGH PASS **Model** *HP–		**50**	**100**	**150**	**200**	**300**	**400**	**500**	**600**	**700**	**800**	**900**	**1000**
Pass Band (MHz)	start, max.	41	90	133	185	290	395	500	600	700	780	910	1000
	end, min.	200	400	600	800	1200	1600	1600	1600	1800	2000	2100	2200
Min. 20dB Stop Frequency (MHz)		26	55	95	116	190	290	365	460	520	570	660	720

Prices (ea.): P $12.95 (6-49), B $27.95 (1-49), N $30.95 (1-49), S $29.95 (1-49)

*Prefix P for pins, B for BNC, N for Type N, S for SMA *example:* **PLP-10.7**

CIRCLE NO 3

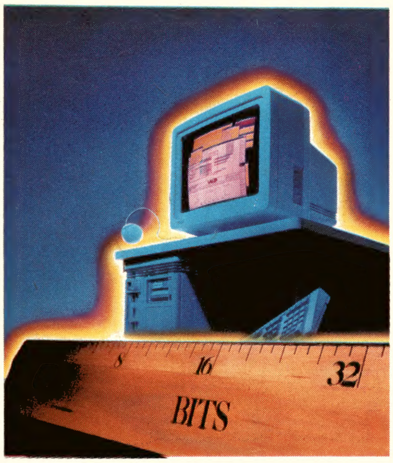
C105 REV. ORIG.

Volume 31, Number 13

EDN

June 26, 1986

ELECTRONIC TECHNOLOGY FOR ENGINEERS AND ENGINEERING MANAGERS



On the cover: *Standard 32-bit workstations measure up to demanding engineering tasks, so CAE vendors are offering software that runs on machines like DEC's VAXstation II, Apollo's Domain, or Sun Microsystems' Sun-3. See pg 134. (Photo by Imagination, courtesy Valid Logic Systems Inc)*

DESIGN FEATURES

Special Report: Software packages for standard 32-bit CAE/CAD workstations 134

CAE-software vendors are switching from selling proprietary packages to offering their software for the de facto standards among 32-bit workstations. Because these machines run a wide variety of CAE and CAD programs, you can use a single 32-bit workstation for all your CAE tasks.—*Eva Freeman, Associate Editor*

Basic program eases analysis of phase-locked loops 157

Analyzing second- and third-order phase-locked loops yourself can be a tedious and time-consuming task. Using a Basic program, you can employ a small computer to perform all the necessary tasks much faster.—*Ron Rippy, Durham, NC*

Sense-cell MOSFET eliminates losses in source circuit 169

Sensing load currents in circuits using power-MOSFET output stages usually entails inserting a resistor in the MOSFET's source circuit. Unfortunately, this sensing resistor causes power losses and adds to the FET's on-resistance. Another type of FET solves these problems by reserving a portion of its cells for sensing source current.—*Warren Schultz, Motorola Inc*

CRT display circuit eliminates need for controller chip 185

A bit-mapped CRT display doesn't necessarily require a complex controller chip. A μC chip and a dual-port video-RAM chip form the core of a simple display-controller circuit.—*David Davidian, NEC Electronics Inc*

C compilers speed single-chip-μP development 213

Although it was once thought impossible, you can now write programs in C for single-chip microprocessors, such as the Intel 8051, Hitachi 6301, or Motorola 6801. You can therefore write and debug substantial parts of an application on a host computer. Should you have to change μPs, you can easily recompile your C code.
—*Corey Satten, John Fluke Manufacturing Co*

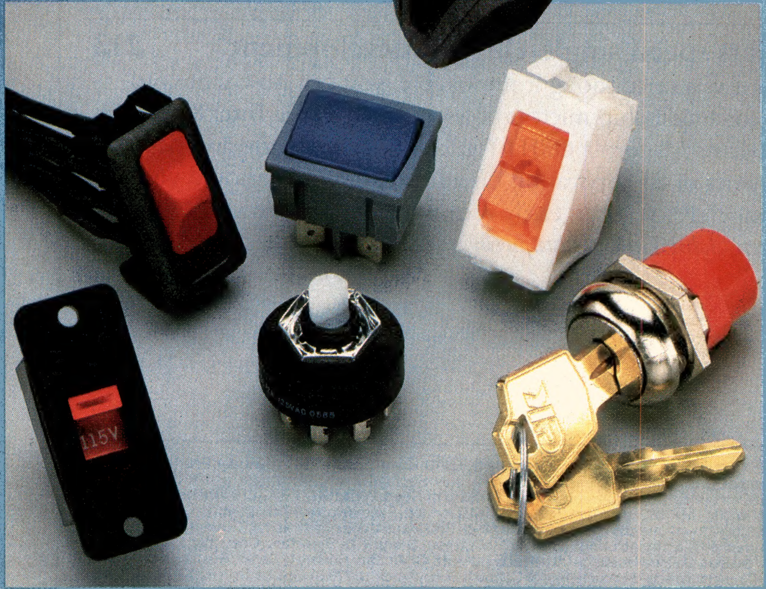
Continued on page 7

EDN (ISSN 0012-7515) is published 45 times a year, biweekly with one additional issue in January, February, March, August, and December, two additional issues in April, June, July, September, and November, and three additional issues in May and October by Cahners Publishing, A Division of Reed Publishing USA, 275 Washington Street, Newton, MA 02158. William M Platt, President; Terrence M McDermott, Executive Vice President; Jerry D Neth, Vice President of Publishing Operations; J J Walsh, Financial Vice President/Magazine Division; Thomas J Dellamaria, Vice President Production & Manufacturing; Terrence McDermott, Group Vice President. Copyright 1986 by Reed Publishing USA, a division of Reed Holdings Inc; Saul Goldweitz, Chairman; Ronald G Segel, President and Chief Executive Officer. Circulation records maintained at Cahners Publishing Co, 270 St Paul St, Denver, CO 80206. Second class postage paid at Denver, CO 80202 and additional mailing offices. Postmaster: Send address changes to EDN, 270 St Paul St, Denver, CO 80206.

POWER SWITCHES FROM C&K

NEW Snap-In Slides

The latest addition to the C&K line is the S Series Snap-In Slide Switch. Compact contemporary design with many "Value Added" features, such as wire leads, harnesses with connectors and jumper strips to provide reversing capabilities. Bezels and slides available in nine contrasting or matching colors. Patent Pending.



C&K has the greatest variety of **low cost,** high volume power switches in Slide, Rocker and Rotary motion. Ratings up to 15 amps, single or double pole, with quick connect, solder lug or wire lead terminals. All switches are UL/CSA listed and many are available with International approvals.

To meet today's high-amp applications in the appliance, electrical or electronic markets, C&K has the power switch to meet your every need.

Send for your full line catalog for complete specifications, we'll even send you a Free sample on request. Call or write today. 1-800-334-7729.

C&K®

C&K Components, Inc.
2035 Highway 70 East
Clayton, NC 27520-0687

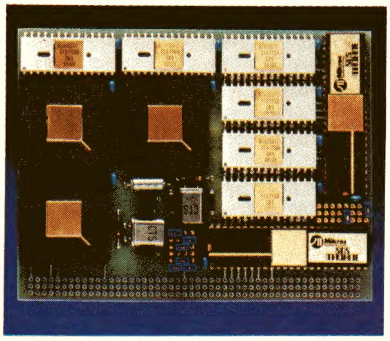
The Primary Source Worldwide®...

CIRCLE NO 5

Continued from page 5

EDN

June 26, 1986



***Implementation of the MIL-STD-1750A instruction set** in VLSI chips is allowing companies to offer single-board 1750A computers as well as complete development systems (pg 87).*

TECHNOLOGY UPDATE

Design and simulate semicustom ICs on low-cost IBM PC-based design systems 51

Using an IBM PC/XT or PC/AT as a hardware platform, you can create a semicustom-IC design system for as little as $15,000. And although a PC doesn't provide the processing power of an engineering workstation, you can use a PC-based system to create a logic design for an IC having as many as 3000 gates.—*David Smith, Associate Editor*

Programmable switched-capacitor filter ICs cut component count in many filter types 71

Todays's universal switched-capacitor filter ICs let you program the design of any classical type of high-order active filter—lowpass, highpass, bandpass, or bandstop (notch)—with only a few external resistors and no external capacitors.—*Denny Cormier, Regional Editor*

Development tools and VLSI chips help you design to military standards 87

The latest advances in VLSI design techniques have led to reductions in the size and price of MIL-STD-1750A processors, and, as a consequence, developers of 1750A-compatible systems and peripherals can now afford to design on examples of the target system.
—*Chris Terry, Associate Editor*

PRODUCT UPDATE

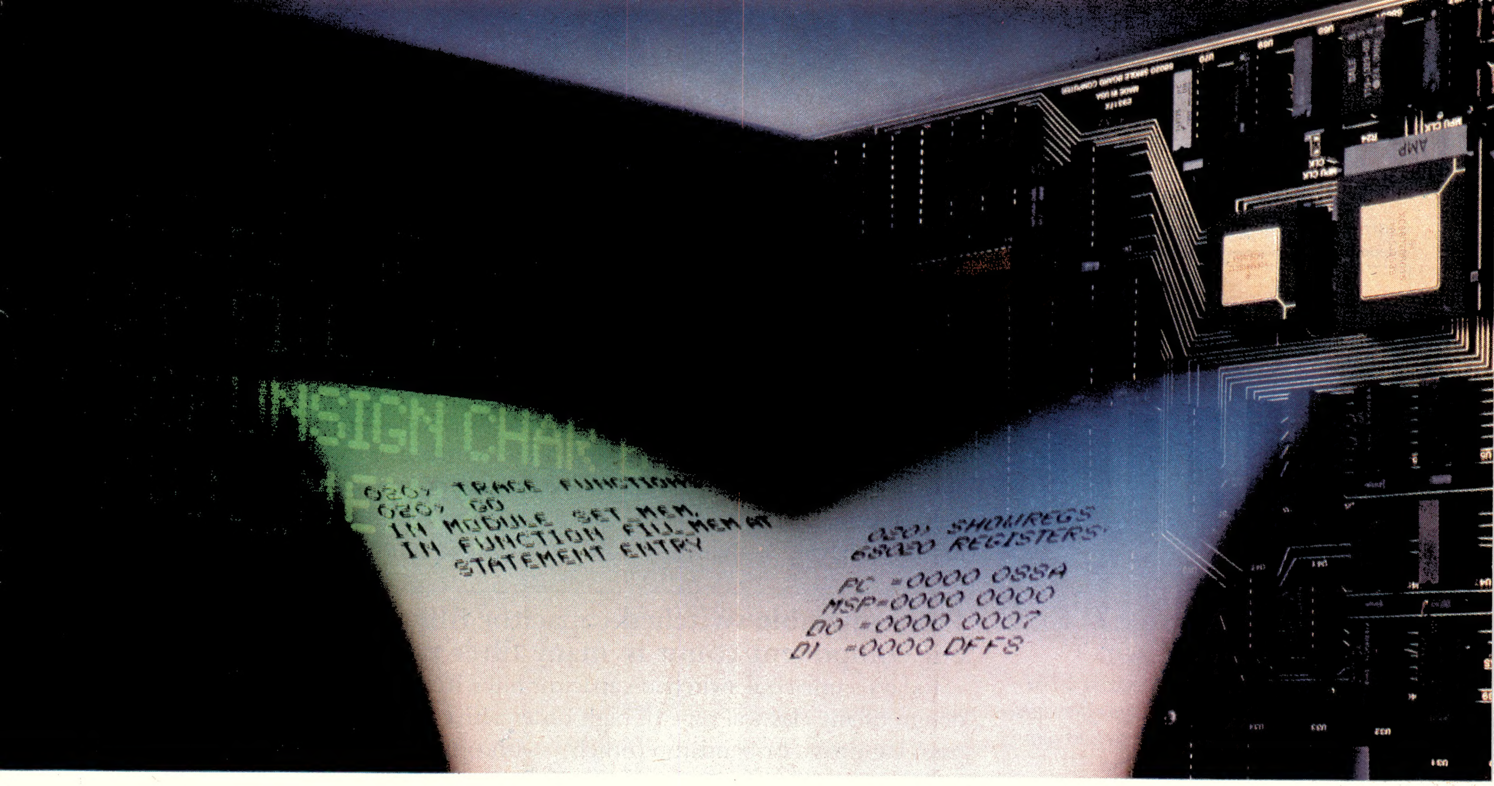
Frame-grabber system 101
Multibus II board family 104
CMOS-processed power-MOSFET driver IC 108
Hardware/software package 110
Development system 112
80286- and J11-based single-board μCs 114
Standard-cell library 116
VME Bus 32032 CPU board 119
30V, 30-mΩ power MOSFETs 120

DESIGN IDEAS

Generator varies pulse delay and duration 225
Solid-state switch offers fast interrupt 226
Circuit generates frequency difference 228
EPROMs simplify TMS32010 memory system 230
Transistor provides thyristor control 233

Continued on page 9

Advertising and editorial offices: 275 Washington St, Newton, MA 02158. Phone (617) 964-3030. Subscription offices: 270 St Paul St, Denver, CO 80206. Phone (303) 388-4511. EDN is circulated without charge to those qualified. Subscription to others: Continental US $90/year, $5/copy; Canada and Mexico $100/year, $6/copy; Europe Air Mail $125/year, $7/copy; all others surface mail $155/year; all other airmail $175/year. Special issue prices may vary. Send requests for qualification forms and/or change of address to subscription office.
© 1986 by Reed Publishing USA, Division of Reed Holdings Inc. All rights reserved.



NOW – A 68020 DEVELOPMENT SYSTEM FOR BOTH SOFTWARE AND HARDWARE ENGINEERS

Introducing Tek's 32-bit Multi-V Development System for the Motorola 68020 and Intel 80286: it makes the software engineer more productive without compromising the hardware engineer's needs. The next generation in microprocessor development, it is an integral part of Tek's Computer Aided Software Engineering (CASE) program, and offers Local Area Networking (LAN), real-time multi-emulation, 9 MB of program memory, "C" tools, integrated HLL debug, and much more.

Multi-V System is the software engineer's ideal development environment. Powerful C Language Development System (C-LANDS II) simplifies embedded microprocessor designs. An Integration Control System (ICS) transparently handles configuration management of prototype resources. The integrated debug system enables complex debug routines in both assembly and high level languages.

The Software Executer expands the software engineer's tools by providing a known good environment. Code runs at processor speeds with the productivity benefits of a development system. Floating point support (68881 or 80287) is standard with both software executer and emulator.

Multi-V is also the hardware engineer's ideal environment—with all the features you'd expect from Tektronix. Multiprocessor designs are easily handled by a high-speed trigger bus which ties real-time emulators together in one mainframe. For team development, multiple tools can reside in the same mainframe, and be accessed via RS-232 or LAN on any VAX™/MicroVAX™ system under ULTRIX™ or VMS™.

Multi-V—the preferred system for both software and hardware engineers—is integral to Tek's Computer Aided Software Engineering (CASE) program. This growing toolset cluster from Tek's Software Development Products Division demonstrates Tek's commitment to software technology. For more information, contact your Tek representative or call today: **1-800-342-5548.**

CASE: From concept to completion, Tek's tools take you all the way.

VAX, MicroVAX, VMS and ULTRIX are trademarks of Digital Equipment Corporation.
Copyright © 1986 by Tektronix, Inc. All rights reserved. MIA604

Tektronix®
COMMITTED TO EXCELLENCE

Circle 6 for Literature

Circle 162 for Sales Contact

Continued from page 7

EDN

June 26, 1986

VP/Publisher
F Warren Dickson
VP/Associate Publisher/Editorial Director
Roy Forsberg
Editor
Gary Legg
Managing Editor
Rick Nelson
Assistant Managing Editor
Joan Morrow
Home Office Editorial Staff
275 Washington St, Newton, MA 02158
(617) 964-3030
Tom Ormond, *Senior Editor*
Jonathan Titus, *Senior Editor*
Bill Travis, *Senior Editor*
Deborah Asbrand, *Staff Editor*
Joanne Clay, *Staff Editor*
Tarlton Fleming, *Associate Editor*
Eva Freeman, *Associate Editor*
Clare Mansfield, *Staff Editor*
Charles Small, *Associate Editor*
David Smith, *Associate Editor*
George Stubbs, *Staff Editor*
Chris Terry, *Associate Editor*
Valerie DeSalvo, *Assistant Editor*
Helen McElwee, *Assistant Editor*
Cynthia B Rettig, *Assistant Editor*
Steven Paul, *Production Editor*
Editorial Field Offices
Margery S Conner, *Regional Editor*
Newbury Park, CA: (805) 499-7901
Denny Cormier, *Regional Editor*
San Jose, CA: (408) 296-0868
Bob Cushman, *Special Features Editor*
Port Washington, NY: (516) 944-6524
Chris Everett, *Regional Editor*
San Jose, CA: (408) 296-0868
Steven H Leibson, *Regional Editor*
Boulder, CO: (303) 494-2233
J D Mosley, *Regional Editor*
Arlington, TX: (817) 465-4961
Maury Wright, *Regional Editor*
San Diego, CA: (619) 748-6785
Peter Harold, *European Editor*
0603-630782
(St Francis House, Queens Rd,
Norwich, Norfolk NR1 3PN, UK)
Contributing Editors
Robert Pease, Bob Peterson, Don Powers
Editorial Services
Kathy Leonard, *Office Manager*
Darlene Thomas, Nancy Weiland
Art Staff
Susan Barrow-Williams, *Director*
Kathleen Ruhl, *Assistant Director*
Roseanne D Coveney, *Illustrator*
Chin-Soo Chung, *Illustrator*
Debi Queally, *Illustrator*
Production/Manufacturing Staff
William Tomaselli, *Production Supervisor*
Donna Pono, *Production Manager*
Patricia Hadidian, *Production Assistant*
Elizabeth Wojciechowicz, *Production Assistant*
Diane Malone, *Composition*
Graphics Director
Norman Graf
VP/Production/Manufacturing
Wayne Hulitzky
Director of Production/Manufacturing
John R Sanders
VP/Research
Ira Siegel
Marketing Communications
Deborah Virtue, *Manager*
Jennifer Ware, *Promotion Manager*
Corie Rand, *Promotion Coordinator*
Susan Odell, *Promotion Assistant*

EDITORIAL 45

Changes similar to those in the computer industry of the late '60s and early '70s are occurring in computer-aided engineering. CAE system integrators are supporting just a few "standard" workstations, thinning the ranks of would-be workstation manufacturers just as the ranks of computer manufacturers have been thinned.

NEW PRODUCTS

Computer-Aided Engineering 238
Computer-System Subassemblies 240
Computers & Peripherals 244
Components & Packaging 250
ICs & Semiconductors 254
Instrumentation & Power Sources 256
International 260
Software 264

PROFESSIONAL ISSUES 277

Software users and vendors square off over the issue of product responsibility.—*Richard Beutel, Washington, DC*

LOOKING AHEAD 295

Supercomputer sites to grow by 60% annually through '90. . . Market for PC-based CAD grows despite limitations.

DEPARTMENTS

News Breaks 19
News Breaks International 22
Signals & Noise 30
Calendar 36
Leadtime Index 126
Business/Corporate Staff 266
Literature 273
Software Review 274
Career Opportunities 280
Advertisers Index 293

CP BPA ABP
Cahners Publishing Company ☐ A Division of Reed Publishing USA ☐ Specialized Business Magazines for Building & Construction ☐ Electronics & Computers ☐ Foodservice ☐ Manufacturing ☐ Book Publishing & Libraries ☐ Medical/Health Care ☐

WE COULD HAVE
CALLED IT A
32-BIT
MICROPROCESSOR.

WE COULD HAVE
CALLED IT A
10-MIP
COMPUTING ELEMENT.

WE COULD HAVE
CALLED IT THE FIRST
CONCURRENT
SOLUTION.

INSTEAD
WE CALL IT THE
TRANSPUTER.

INMOS introduces the transputer family. A range of evaluation boards for the first transputers is available now.

The transputer is a fast, easy to use VLSI component designed for applications ranging from single microprocessor systems to supercomputers.

The IMS T414 is the first transputer, integrating a 32 bit microprocessor, four inter-transputer communication links, 2 Kbytes of RAM, a 32 bit memory interface and a memory controller onto a CMOS chip.

The microprocessor runs at 10 MIPS and is designed specifically for the execution of high level languages. It combines direct support for multi-tasking, floating point, block transfer and record handling with sub-microsecond procedure call and task switching.

Each transputer link provides a full duplex, 10 Mbits/sec, point to point connection with an on chip DMA controller. Links are used for inter-transputer communication or, via an INMOS Link Adaptor, interfacing to industry standard byte wide peripherals.

The memory interface provides access to a linear 4 Gbyte address space at a data transfer rate of up to 25 Mbytes/sec.

Transputers are designed for ease of engineering. All transputer family devices operate from a single 5 MHz clock input, which is used to derive high speed internal clocks for all on chip systems.

When transputers are directly connected via links, additional components are not necessary. Independent or common clocking can be used, regardless of timing skew.

The configurable memory controller also requires no external components. It provides all the necessary timing and refresh signals for memory systems, comprising any mix of ROM, SRAM, DRAM and memory mapped peripherals.

Transputers are designed for ease of programming. INMOS offers development systems which provide integrated editing, compiling and source level debugging for both single and multiple transputer applications, using C, Pascal, Fortran and occam.

In applications requiring only a single computing element, the transputer's speed, minimal support component requirements and programming efficiency provide significant cost/performance advantages over conventional microprocessors.

Systems of any size can be built from interconnected transputers, using the links. The same program can be configured to run on one, tens or thousands of transputers allowing a simple trade off between performance and cost.

The transputer family already includes 32 bit and 16 bit transputers, peripheral controllers, evaluation boards and development tools. Start assessing its capability for yourself now with an IMS T414 evaluation board.

TRANSPUTER PRODUCTS	
IMS T414	**32 Bit, 2 Kbyte RAM, 4 Transputer links**
IMS T212	**16 Bit, 2 Kbyte RAM, 4 Transputer links**
IMS C001	Transputer Link Adaptor, Separate 8-Bit input and output
IMS C002	Transputer Link Adaptor, Multiplexed 8-Bit input/output

DEVELOPMENT TOOLS	
IMS D100	INMOS Transputer Development System
IMS D600	Transputer Development Software, VAX-VMS
IMS D700	Transputer Development Software, IBM-PC

EVALUATION BOARDS	
IMS B001	Double Eurocard, IMS T414, 64 Kbyte RAM, 2 x RS232C ports
IMS B002	Double Eurocard, IMS T414, 2 Mbyte RAM, 2 x RS232C ports
IMS B004	IBM-PC add on card, IMS T414, 1 Mbyte RAM

inmos ● IMS and occam are trademarks of the INMOS Group of Companies.

INMOS Corporation, P.O. Box 16000, Colorado Springs, Colorado 80935, USA. Tel: (303) 630-4000. Tx: (910) 920-4904
INMOS Limited, Whitefriars, Lewins Mead, Bristol, U.K. BS1 2NP.
Tel: 0272 290861 Tx: 444723.
INMOS GmbH, Danziger Strasse 2, 8057 Eching, West Germany.
Tel: 089 319 10 28. Tx: 522645.
INMOS Sarl, Immeuble Monaco, 7 Rue Le Corbusier, Silic 219, 94518 Rungis Cedex, France. Tel: (1) 687.22.01. Tx: 201 222.

For a complete data pack on the Transputer and its support products, fill in the response coupon, and post to INMOS Corporation P.O. Box 16000 Colorado Springs, Colorado 80935, USA.
For faster response, call (303) 630-4000

EDN62686

Name____________________

Title____________________

Company____________________

Street/PO address____________________

____

City/State/Zip____________________

Country____________________

Telephone____________________

☐ Please send Transputer data pack
☐ Please have a salesman call
☐ I am interested in ordering an Evaluation Board

inmos®
TRANSPUTER FAMILY

CIRCLE NO 7

The only integrated CAE environment.

The Total Engineering Solution

CASE Technology offers the only fully integrated CAE system that operates on standard IBM PC/XT/ATs, MicroVAX workstations and VAX minicomputers. The system includes: schematic design, 12-state logic and fault simulation, worst-case timing verification, circuit simulation, and PCB physical layout.

The CASE system possesses the most powerful schematic design tools available. Its power lies in its interactive speed, intelligent user interface and system configurability. The system also supports the complete SCALD hierarchical design concepts.

Intelligent Schematics—The Nucleus of Custom CAE

With CASE schematic design as the nucleus of your CAE environment, you can use each CAD/CAE system to do what it does best. You're not locked into one vendor. Integrate Tegas, Spice, Cadat, Silos, Scicards, Redac, Computervision, Applicon, Calay, Telesis, Mentor, IBM CBDS and Prime EDMS.

One Schematic is Worth a Thousand Netlists

The CASE system saves you hundreds of man-hours by allowing a bi-directional interface with other design

VAX, MicroVAX & PC

systems. This capability preserves your investment in existing CAD/CAE systems. Preserves the enormous effort that went into developing component libraries. Only CASE offers this advantage.

Unlike netlist interfaces, CASE's graphic interface allows you to re-display the same schematic on other CAD/CAE systems. Access to these schematics expedites design changes, logic simulation and PCB physical design. Only CASE has this capability.

Once you move your schematic to another system and make changes, you'll want to back-annotate. CASE provides a program that simplifies back-annotation between systems. With a basic "was-is" list, CASE can automatically update schematics. Only CASE provides this feature.

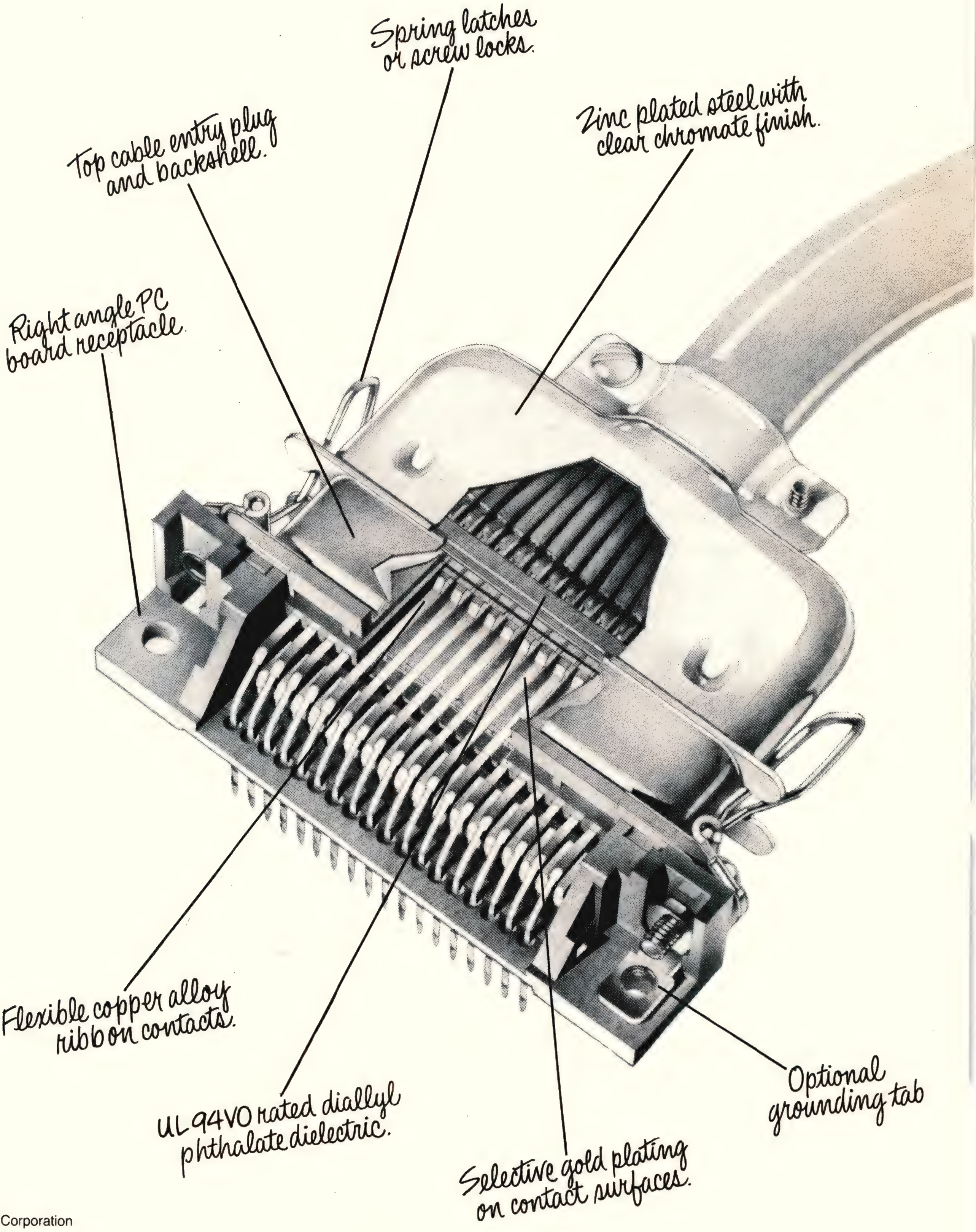
The CAE Price/Performance Leader

With more than 1000 installed systems, CASE Technology has developed a solid reputation as the CAE price/performance leader. What was once "the best kept secret in CAE" is now being touted throughout the world.

CASE Technology, Inc., 633 Menlo Avenue, Menlo Park, CA 94025. Phone: (415) 322-4057; Telex: 506513.

CIRCLE NO 9

CASE TECHNOLOGY


Spring latches or screw locks.
Zinc plated steel with clear chromate finish.
Top cable entry plug and backshell.
Right angle PC board receptacle.
Flexible copper alloy ribbon contacts.
UL 94VO rated diallyl phthalate dielectric.
Selective gold plating on contact surfaces.
Optional grounding tab

©1985 Allied Corporation

Wrapped up: High density packaging.

Low cost Amphenol® miniature ribbon connectors mass terminate, shield or filter up to 64 contacts.

The wide choice of miniature ribbon connectors available from Amphenol Products makes it easy for you to secure the right input/output connection for telecommunication, computer, business and test equipment.

When durability and EMI/RFI shielding are required choose steel shelled 57 Series Micro Ribbon® connectors for solder termination, or 157 Series Micro-Pierce® connectors for solderless IDC termination.

To meet tough EMI/RFI requirements like FCC Docket 20780, choose Amphenol FCC Micro Ribbon filter connectors. With chip capacitors that shunt EMI/RFI noise to ground and remove it from the signal, these connectors save up to half the cost of competitive models.

When economy and easy assembly are prime considerations, low cost Amphenol plastic body connectors are your logical choice.

Our new 50 contact, running cable IDC connector, for example, features an all plastic body and hood plus a snap-in latching mechanism that secures without screws.

Other models combine plastic with metal front shell construction for economy and shielding capabilities.

All feature time-proven flexing action contacts with selective gold plating for easy mating and reliable electrical continuity.

For more information, contact your nearest Amphenol Products sales office.

Amphenol Products world headquarters:
Lisle, IL 60532—USA—Telex: 190215

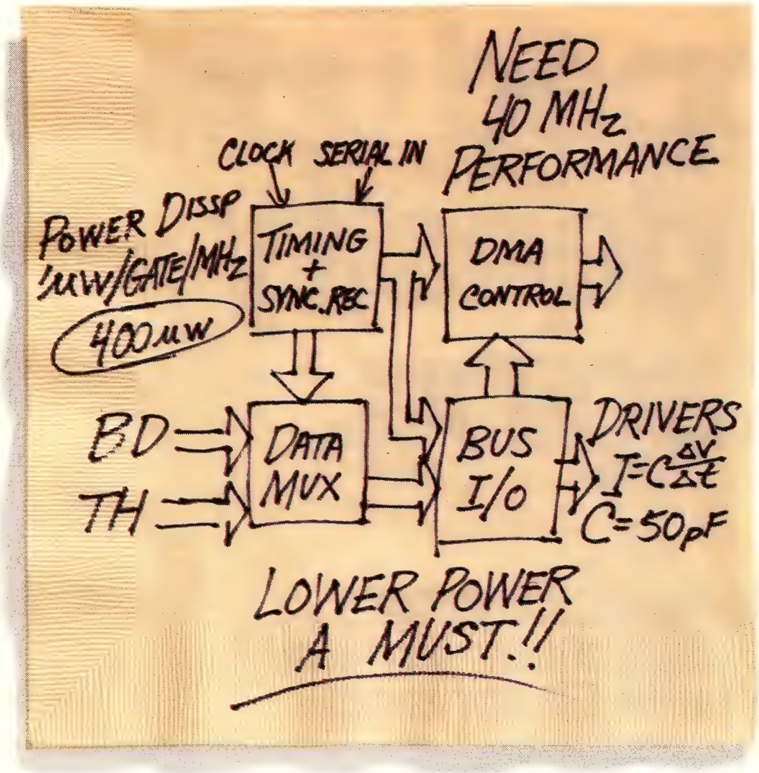
CANADA: Montreal, (514) 482-5520 • Ottawa, (613) 226-2727 • Toronto, (416) 291-4401 • Vancouver, (604) 278-7636

EUROPE: Austria—Vienna, (43) 222-951511 • **England**—Whitstable (44) 227-264411; Romsey, (44) 794-517575 • **France**—Dole, (33) 84-728113; Suresnes, (33) 1-7729113 • **W. Germany**—Heilbronn, (49) 7131-4861 • **Italy**—Arese, (39) 2-938-5161 • **Netherlands**—Ijsselstein (31) 3408-87844 • **Spain**—Barcelona, (34) 3-237-3100 • **Sweden**—Upplands Vaesby, (46) 760-88035

FAR EAST: Hong Kong—Kowloon (852) 3-681283 • **India**—Poona, 83363 • **Japan**—Tokyo, (81) 3-379-2111

ALLIED Amphenol Products

CIRCLE NO 10



A simple rea
Plessey your A

It's simple, but it's a CLASSIC.™ The Custom Logic Analysis and Simulation System for Integrated Circuits. From Plessey. For today's semicustom world.

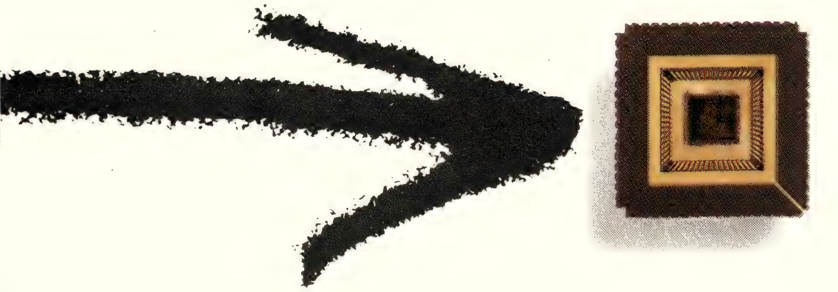
CLASSIC is more than user friendly. It allows System Designers to concentrate on what they do best—design systems—not struggle with complex software.

You control a precise, rapid-fire design process which can, for example, put a 10,000+ gate prototype in your hand four weeks after you deliver the layout tape.

And we're talking about a 98 percent first time hit rate. Guaranteed! In 2- or 3-micron high-performance CMOS.

Plessey CLASSIC puts the design tools you need at your very own workstation. From initial design, through schematic capture, to simulation and test, you're in control working with the finest design tools available.

And, once you're finished, who better than Plessey to handle the manufacturing? We're a $2 billion company with more



son to make
SIC company.

than 25 years of ASIC experience.

So, if you're looking for a reason to select an ASIC company, keep it simple. And contact the one company that stays with you from idea to completed circuit. Call 1-800-321-0871. Or write to Plessey Semiconductors, 3 Whatney, Irvine, CA 92718.

Outside the U.S. call SWINDON (0793) 36251. Or write to Plessey Semiconductors Limited, Cheney Manor, Swindon, Wiltshire, United Kingdom SN2 2QW. In Brussels, Belgium (02) 7339730; Les Ulis, France (6) 4462345; Munich, Germany (089) 23620; and Milan, Italy (02) 659-6081.

PLESSEY

ASIC from thought to finish.

For free on-line information, dial 1-800-345-7335 with any 80-column ASCII terminal or PC and a 300 or 1200 baud modem (EVEN or IGNORE parity, 7data bits, 1 stop bit). At "Enter Response Code", Type GR8ASICS. In Conn. Dial (203) 852-9201.

CIRCLE NO 11

To be #2 we developed a lot of firsts.

We were the first to introduce software-controlled programmers way back in 1973.

And the first to program PALs and IFLs with a universal programmer.

For more firsts that are moving Stag from #2 to Data I/ O's #1 position, call or write us today.

Stag Electronic Designs Ltd.
Stag House, Tewin Court
Welwyn Garden City, Herts AL71AU
Tel: (07073) 3214B
TELEX: 8953451

®copyright Stag Microsystems, Inc.
PAL is a registered trademark of Monolithic Memories, Inc.
BRAL is a registered trademark of Stag Microsystems, Inc.

Firsts that will keep your Stag PPZ Universal Programmer from becoming obsolete in a few weeks... a few months... a few years.

Firsts like:

- Completely self-contained software control modules with proven programs for all programmable technologies including PAL®s, IFLs, and Micros, as well as bipolar and MOS PROMs and others
- 512K bits of memory, expandable to 64M bits
- Integral CRT with "super menu" techniques for fast, easy operation
- A light pen for dramatically simple interactive editing and programming
- Boolean entry support (BRAL™) for PALs and IFLs
- Two RS232C, an IEEE-488, and a parallel port to interface with any development system

And a whole lot more to ensure that your PPZ will be valuable to you for years.

stag

Moving Quickly to Become

CIRCLE NO 12

NEWS BREAKS

EDITED BY JOAN MORROW

4k×4-BIT STATIC RAM DROPS CMOS ACCESS TIME TO 20 nSEC

Boasting the fastest CMOS access and cycle times for a 4k×4-bit static RAM, the MK41H68 from Thomson Components-Mostek (Dallas, TX, (214) 466-6000) offers 20-nsec address-access and read-cycle times. The chip is protected against static discharge with low-capacitance TTL-compatible inputs and outputs. It requires no external clocks or timing strobes. A power-down feature automatically reduces power dissipation when the $\overline{\text{CE}}$ line becomes inactive. One 5V power source is all you need to power the chip, which costs $34.30 (100).—J D Mosley

IC-VERIFICATION SYSTEM OFFERS 100-pSEC RESOLUTION

In addition to incorporating as many as 480 test channels, an IC-verification system from Integrated Measurement Systems (Beaverton, OR) lets you stimulate and sample signals with resolution as small as 100 psec. The system also measures signal currents in 50-pA increments and signal voltages in 1-mV increments. Built from independent subsystems, the Logic Master 2000 generates stimulus patterns, acquires IC response data, and compares acquired response data with expected response data. It includes an interface to a host computer or workstation, allowing you to transfer test patterns from your IC-design system. A 256-channel system costs $185,000.—David Smith

CMOS FLOATING-POINT CHIP SETS BOAST 50-nSEC CLOCK CYCLE

Integrated Device Technology's (Santa Clara, CA, (408) 727-6116) two 64-bit chip sets, the IDT72064/72065 and the IDT72264/72265, handle IEEE-754 (Version 10.0) floating-point operations. Fabricated with the company's proprietary 1.2-μm CEMOS-IIC process, both chip sets accept dual 32-bit inputs and provide a 32-bit result every 50 nsec, yet dissipate only 750 mW of power per device from one 5V supply. For pipelined operations, the IDT72064/72065 and IDT72264/72265 devices deliver double-precision multiply times of 650 and 450 nsec, respectively. The company will sample military and commercial versions in October in standard 144-pin pin-grid-array packages. Pricing will be less than $700 (100).—Denny Cormier

ASIC VENDOR COMPILES STANDARD CELLS TO YOUR SPECS

If you go to Gould Semiconductors (formerly Gould/AMI, Santa Clara, CA) with a list of standard cells you need for an IC design, the vendor can use its Score library-development system to create a customized cell library in just a few days. The system's 22 cell compilers generate cell symbols, layout, timing information, and a data sheet based on your specifications. You specify cell height, output load, signal propagation delay, and functional options. The system compiles a variety of cells ranging from inverters to flip-flops. Using these cells, you design your IC using the vendor's design tools. This service is free to IC designers who use Gould's standard cells.—David Smith

QIC-120 TAPE DRIVE FITS 5¼-IN. HALF-HEIGHT FORM

Wangtek (Simi Valley, CA, (805) 583-5255) offers a 125M-byte QIC-120 tape drive along with its QIC-24 products. The 5125E drive features a QIC-36 interface and the QIC-120 format. The half-height 5¼-in. drive also provides downward compatibility with 60M-byte QIC-24 products. Tape-edge referencing and off-track sensing ensure data reliability and cartridge interchangeability. The 5125E will sell for $495 (1000) when samples become available next month. The company also plans to offer SCSI, IBM PC, and QIC-02 interfaces for the drive.—Maury Wright

NEWS BREAKS

DUAL REMOTE TERMINAL INTERFACE IS COMPATIBLE WITH 1553B

The UT1553B remote terminal interface (RTI) from United Technologies Microelectronics Center (Colorado Springs, CO, (800) 645-8862) is a monolithic implementation of a dual RTI that links the military 1553 serial bus to μP and memory systems. The device contains redundant Manchester decoders, a Manchester encoder, and serial-parallel and parallel-serial converters. It complies with MIL-STD-1553B Notice 2 according to testing performed at the USAF Systems Engineering Avionics facility. It supports a dual-redundant data bus and implements all dual-redundant, remote terminal mode codes and operational functions including broadcast commands. The UT1553B RTI costs $622 (less than 100) and is available in 84-pin LCC, PGA, and ceramic quad packages.—Steven H Leibson

20,000-GATE ARRAY INCORPORATES TEST CIRCUITRY

The HC20000 CMOS gate array from Honeywell Inc (Colorado Springs, CO) integrates 20,000 equivalent 2-input gates and includes test circuitry that allows you to test the entire array using five pins. Two thousand gates implement the test feature; the remaining gates achieve 600-psec delays and permit 80% typ utilization. The test circuitry, called built-in evaluation and self-test (BEST), contains input and output shift registers that allow you to store and access test patterns through two of the test pins. A function register controls testing functions, and a check-sum generator calculates proper chip response to a series of test patterns. Using these features, you can test your array using only five pins on the device. Development cost for the HC20000 typically falls between $120,000 and $150,000; five prototypes are delivered six to eight weeks after verification of layout.—David Smith

SERIES 200 AND 300 COMPUTERS GET VME INTERFACE, ADA COMPILER

The 98646A VME Bus interface from Hewlett-Packard (Palo Alto, CA) allows you to connect HP 9000 Series 200 and 300 computers to VME Bus-based systems. The product includes interface cards for both the computer and the VME card cage, a connecting cable, and driver software for Basic, Pascal, or the HP-UX derivative of the Unix operating system. Using the interface, you can achieve transfer rates greater than 1M byte/sec between the computer and VME cards. The 98646A costs $1250 to $1450, depending on the software driver selected.

The company has also introduced validated, single-user ($3125) and multiuser ($4275) versions of an Ada compiler for the Series 200 and 300 computers. The compiler runs under HP-UX and offers full access to HP-UX services, utilities, and system libraries including graphics, windows, and I/O control. It's based on compiler software from Alsys (La Celle St Cloud, France).—Steven H Leibson

5V 28-PIN IC OFFERS μP-BASED CONTROL OF T1 INTERFACE

Offering a single-chip solution to your T1 line-interface problems, the CSC61544 from Crystal Semiconductor (Austin, TX, (512) 445-7222) features a programmable, pulse-shaping line driver. Similar devices from other manufacturers typically rely upon external RC circuits to achieve final pulse shaping. Combining the ability to transmit and receive data, this 28-pin IC operates from one 5V supply and dissipates 500 mW max. A line-length-selection feature in the transmission circuit ensures accurate pulse shaping; you can select from as many as five line lengths extending as far as 655 ft. A crystal-controlled jitter attenuator removes as many as 14 unit intervals of jitter (p-p) from outgoing data; its phase-lock loop is immune to false-lock problems at harmonic frequencies. The IC costs $23 (1000).—J D Mosley

NCR'S SPECIAL FORCES.

Meet NCR's high-rel Mil ASIC team.

A semicustom design group trained to meet the specific reliability and performance requirements of defense and aerospace contractors.

A team rigorously drilled to provide fast turnaround. We can turn gate arrays in as little as four weeks and standard cells in as little as eight weeks after completion of design.

And NCR will produce those parts by the book. All parts are products of a quality system based on MIL-Q-9858A. Screening and quality conformance inspection test methods can be conducted according to MIL-STD 883C, Methods 5004/5005 and Method 5010 on a stand-alone basis.

Mobility: A key military strategy.

NCR's ASIC design system keeps the military's options open. Our product family provides an integrated set of hardware and software products allowing true design migration from gate arrays to standard cells and from 3 μm to 2 μm geometries —reducing design cycles and production costs.

The allies.

The Mil ASIC group is supported by the entire NCR Microelectronics Division.

It's an internal second source that includes three separate fabs and hundreds of ASIC specialists. Not to mention our separate Customer Owned Tooling/Foundry group.

NCR also provides customers with an external second source. Our industry leading alliance covers CMOS gate arrays, cell libraries, CAD design tools and future generation ASIC products.

So whenever needed, we have reinforcements.

The special forces of NCR. We're waiting for your order.

For more information call NCR's Microelectronics Division, 1-800-543-5618. Or write Mil ASIC Group, 8181 Byers Road, Miamisburg, OH 45342.

QUALITY, SERVICE AND SUPPORT. YOU CAN EXPECT IT FROM NCR.

NCR

NCR Microelectronics Division

© 1986 NCR Corporation

CIRCLE NO 14

NEWS BREAKS: INTERNATIONAL

EDITED BY JOAN MORROW

STATIC RAMs FEATURE 55- AND 70-nSEC ACCESS TIMES

Two 256k-bit static RAMs from Fujitsu Ltd furnish access times of 55 and 70 nsec. The MB81C86 Series devices, which are organized as 64k words×4 bits, are designed to be employed as the main memory in super computers and as the cache memory for medium and small computers. Power consumption is 550 mW during operation and 55 mW during standby. The memories come in 28-pin DIPs or 32-pad LCCs for $102.85 and $114.29, respectively, in sample quantities.

DESKTOP COMPUTERS ARE IBM PC/AT and PC/XT COMPATIBLE

The Business Partner 286 and the Business Partner PC from Panasonic Industrial Co are IBM PC/AT- and PC/XT-compatible desktop computers. The 286 features 10 expansion slots, clock speeds of 6 or 8 MHz, 512k bytes of RAM, and a 5¼-in. floppy-disk drive (in either a 1.2M- or 360k-byte configuration). It costs approximately $3000. The PC/XT-compatible Business Partner PC, priced at approximately $1500, provides 256k bytes of RAM, a single or dual 5¼-in., 360k-byte floppy-disk drive, and a clock speed of 4.77 or 7.16 MHz.

TWO COMPANIES OFFER MASKED ROMs WITH 200-nSEC ACCESS

A 2M-bit CMOS masked ROM, the TC532000P from Toshiba Corp, and the HN62302P, a similar device from Hitachi Ltd, both feature a 200-nsec access time. The former part is organized as 256k words×8 bits and is fabricated using 1.5-μm design rules. It comes in a 32-pin package for $22.85. Hitachi's masked ROM is housed in a 40-pin package; samples cost ¥2600 ($14.85).

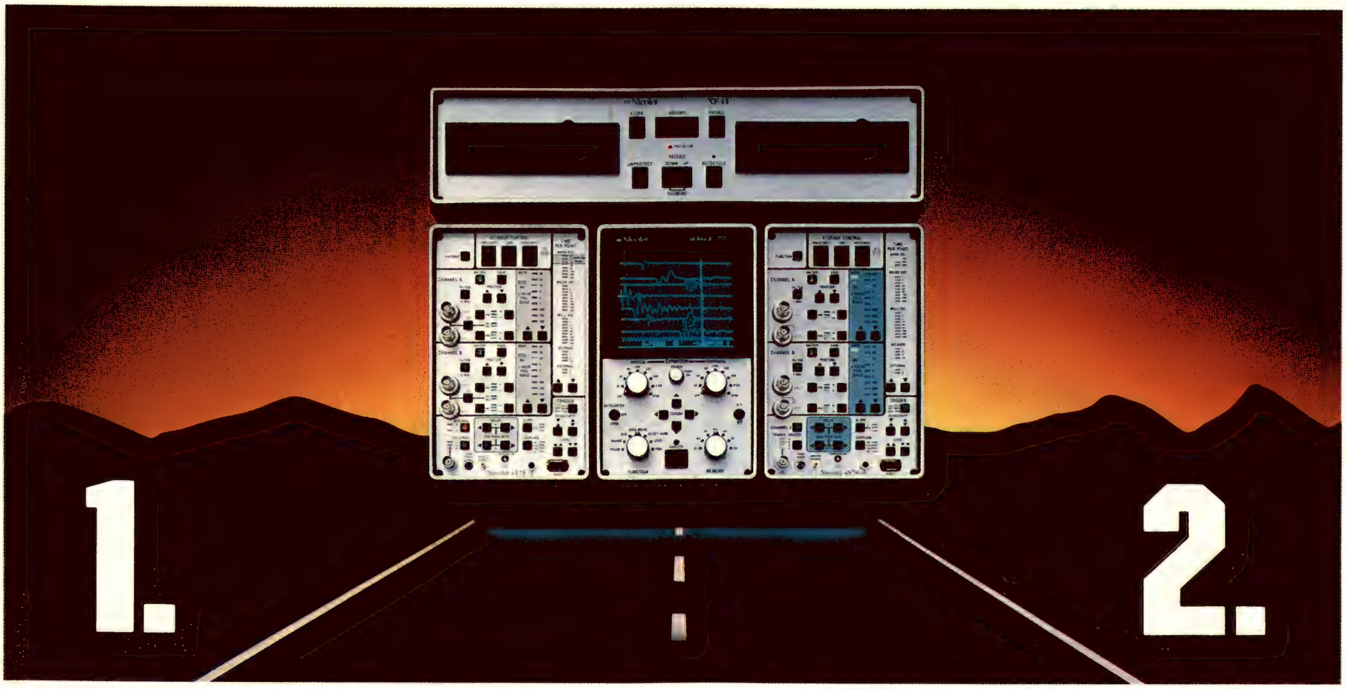
FLOPPY-DISK CONTROLLER HAS BUILT-IN DATA SEPARATOR

The MSM6241RS CMOS floppy-disk controller from Oki Electric Industry incorporates a data-separator circuit and features 100-mW power dissipation. One MSM6241RS can control as many as four floppy-disk drives, including 3½-, 5¼-, and 8-in. types. Sample price for the controller is ¥3000 ($17.14), and Oki expects to drop the price to approximately $8.57 (10,000) when it starts to produce the device in mass volume.

HOME COMPUTER FEATURES ARTIFICIAL INTELLIGENCE

Sega Enterprise, a video-game manufacturer, has introduced a home computer that incorporates artificial intelligence. Designed to be used with a television receiver, the computer consists of a B5-size input tablet, a keyboard, and a cursor controller. The artificial-intelligence language, Sega Prolog, includes Japanese-language processing and image-processing capabilities. In an educational program, for example, a child can instruct the computer to draw a morning's occurrences by merely typing the incidents in everyday language. The computer, which uses an NEC V20 μP, costs ¥87,000 ($500); the programs will range from $28 to $50. The company plans to sell 500,000 of the home computers during the next three years, but has not disclosed any export plans.

THE FIRST NAME IN DIGITAL SCOPES



TWO DIGITAL SCOPES IN ONE.

The Acquisition.

With sweep speeds from days to nanoseconds and resolution up to 15 bits, the 4094 digital 'scope can capture the most elusive signals. Every plug-in has 16K of memory, viewable trigger set-up and independent pre- or post-trigger delay on each channel. Signal averaging is standard and our latest 10 MHz/12-bit plug-in even offers real time manipulation of the incoming signals. With two plug-ins the 4094 can record four channels simultaneously. Or even monitor two slow signals and capture high speed glitches at the same time. All under computer control or via manual operation: whatever your application demands.

The Analysis.

Expand and examine any waveform feature in detail. Use the dual cursors and numerics to measure the time or voltage of any point. Compare live or stored waveforms with each other or with pre-recorded references. Store signals on disk manually or automatically. Use pushbutton programs to manipulate the data or send it to your computer via GPIB or RS232 interface. Complete your report with a hardcopy plot using the XY/YT recorder or digital plotter outputs.

First Time, Everytime.

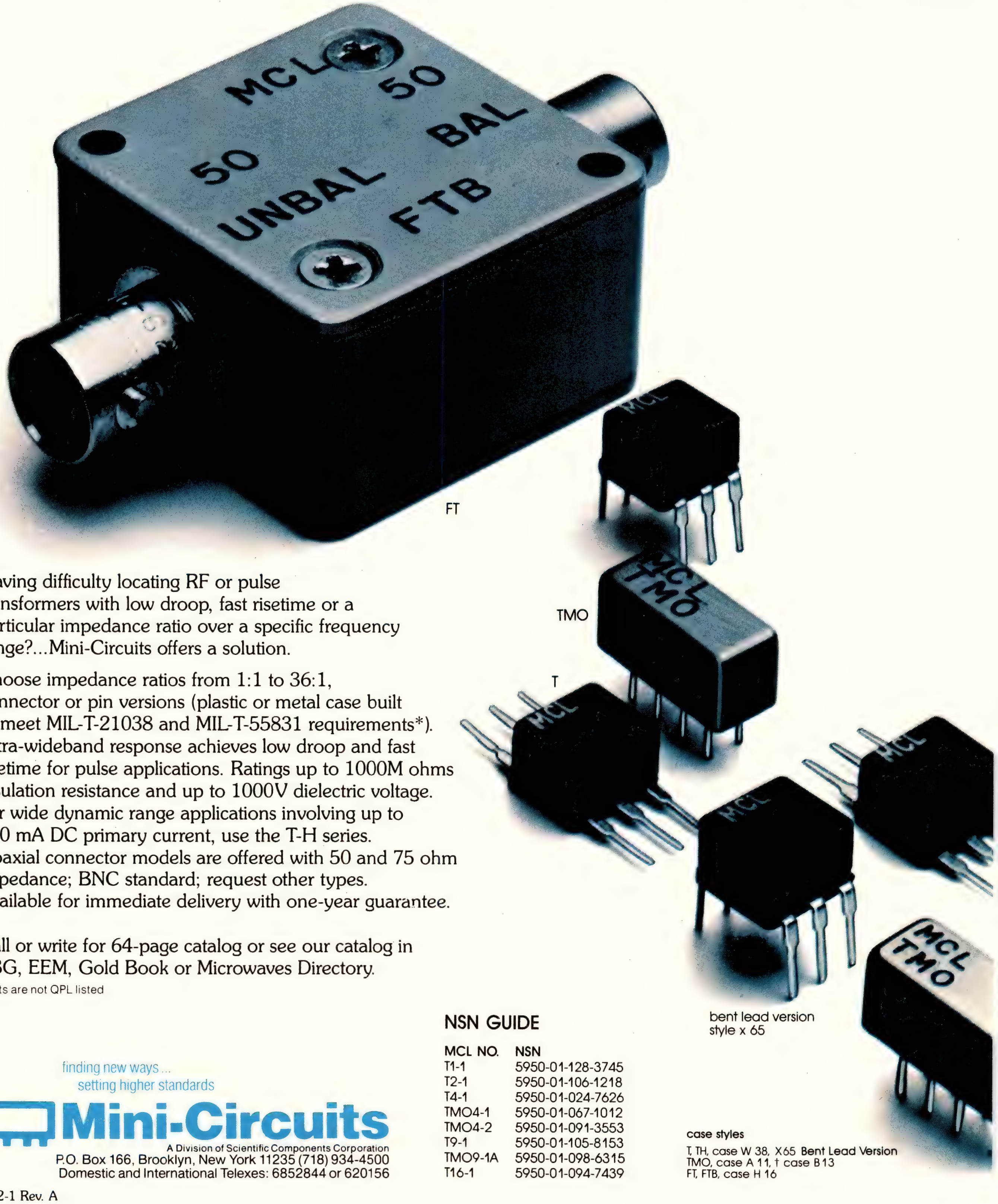
Don't miss important data because of set-up errors. From the World's first in 1973 to the latest models, Nicolet 'scopes are easy to use. Find out how they can be the quickest solution to your signal problems. For more information call 608/273-5008, or write Nicolet Test Instruments Division, P.O. Box 4288, 5225 Verona Road, Madison, WI 53711-0288.

Nicolet

For more information, Circle No. 50

RF trans

over 50 off-the-shelf models...



Having difficulty locating RF or pulse transformers with low droop, fast risetime or a particular impedance ratio over a specific frequency range?...Mini-Circuits offers a solution.

Choose impedance ratios from 1:1 to 36:1, connector or pin versions (plastic or metal case built to meet MIL-T-21038 and MIL-T-55831 requirements*). Ultra-wideband response achieves low droop and fast risetime for pulse applications. Ratings up to 1000M ohms insulation resistance and up to 1000V dielectric voltage. For wide dynamic range applications involving up to 100 mA DC primary current, use the T-H series. Coaxial connector models are offered with 50 and 75 ohm impedance; BNC standard; request other types. Available for immediate delivery with one-year guarantee.

Call or write for 64-page catalog or see our catalog in EBG, EEM, Gold Book or Microwaves Directory.

*units are not QPL listed

NSN GUIDE

MCL NO.	NSN
T1-1	5950-01-128-3745
T2-1	5950-01-106-1218
T4-1	5950-01-024-7626
TMO4-1	5950-01-067-1012
TMO4-2	5950-01-091-3553
T9-1	5950-01-105-8153
TMO9-1A	5950-01-098-6315
T16-1	5950-01-094-7439

case styles
T, TH, case W 38, X65 Bent Lead Version
TMO, case A 11, † case B13
FT, FTB, case H 16

finding new ways...
setting higher standards

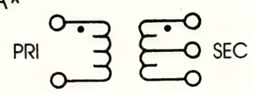
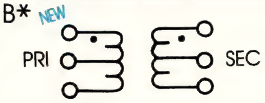
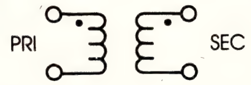
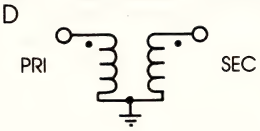
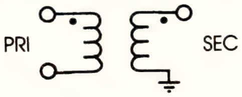
Mini-Circuits
A Division of Scientific Components Corporation
P.O. Box 166, Brooklyn, New York 11235 (718) 934-4500
Domestic and International Telexes: 6852844 or 620156

C72-1 Rev. A

formers

3KHz-800 MHz from $\$2^{95}$

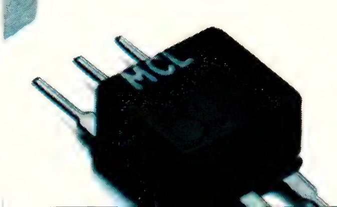
CAPD
now available!
computer-automated performance data

case style number see opposite page.		MODEL NO.	Ω RATIO	FREQUENCY MHz	INSERTION LOSS			PRICE $	
					3dB MHz	2dB MHz	1dB MHz	Ea.	Qty.
A* 	T	T1-1T	1	.05-200	.05-200	.08-150	.2-80	3.95	(10-49)
		T1-6T NEW	1	.003-300	.003-300	.01-150	.02-50	5.95	(10-49)
		T2-1T	2	.07-200	.07-200	.1-100	.5-50	4.25	(10-49)
		T2.5-6T	2.5	.01-100	.01-100	.02-50	.05-20	4.25	(10-49)
		T3-1T	3	.05-250	.05-250	.1-200	.5-70	3.95	(10-49)
		T4-1	4	.2-350	.2-350	.35-300	2-100	2.95	(10-49)
		T4-6T	4	.02-250	.02-250	.05-150	0.1-100	3.95	(10-49)
		T5-1T	5	.3-300	.3-300	.6-200	.5-100	4.25	(10-49)
		T8-1T	8	.03-140	.03-140	.10-90	1-60	6.95	(10-49)
		T13-1T	13	.3-120	.3-120	.7-80	5-20	4.25	(10-49)
		T16-6T NEW	16	.03-75	.03-75	.06-30	.1-20	4.95	(10-49)
	TH	T4-1H	4	8-350	8-350	15-300	25-200	4.95	(10-49)
	TMO	TMO1-1T	1	.05-200	.05-200	.08-150	.2-80	6.45	(10-49)
		TMO2-1T	2	.07-200	.07-200	.1-100	.5-50	6.75	(10-49)
		† TMO2.5-6T	2.5	.01-100	.01-100	.02-50	.05-20	6.75	(10-49)
		† TMO3-1T	3	.05-250	.05-250	.1-200	.5-70	6.45	(10-49)
		TMO4-1	4	.2-350	.2-350	.35-300	2-100	4.95	(10-49)
		TMO5-1T	5	.3-300	.3-300	.6-200	5-100	6.75	(10-49)
		TMO13-1T	13	.3-120	.3-120	.7-80	5-20	6.75	(10-49)
B* NEW 	TT	TT1-6	1	.004-500	.004-500	.02-200	.1-50	5.95	(10-49)
		TT1.5-1	1.5	.075-500	.075-500	.2-100	.1-50	4.95	(10-49)
		TT2.5-6	2.5	.01-50	.01-50	.025-25	.05-10	5.25	(10-49)
		TT4-1	4	.05-200	.05-200	.02-50	1-30	4.95	(10-49)
		TT25-1	25	.02-30	.02-30	.05-20	.1-10	7.95	(10-49)
	TTMO	TTMO1-1	1	.005-100	.005-100	.01-75	.05-40	10.95	(10-49)
C 	T	T1-1	1	.15-400	.15-400	.35-200	2-50	2.95	(10-49)
		T1-6 NEW	1	.01-150	.01-150	.02-100	.05-50	4.95	(10-49)
		T1.5-1	1.5	.1-300	.1-300	.2-150	.5-80	3.95	(10-49)
		T1.5-6 NEW	1.5	.02-100	.02-100	.05-50	0.1-25	4.95	(10-49)
		T2.5-6	2.5	.01-100	.01-100	.02-50	.05-20	3.95	(10-49)
		T4-6	4	.02-200	.02-200	.05-150	.1-100	3.95	(10-49)
		T9-1	9	.15-200	.15-200	.3-150	2-40	3.45	(10-49)
		T16-1	16	.3-120	.3-120	.7-80	.5-20	3.95	(10-49)
		T36-1	36	.03-20	.03-20	.05-10	.1-5	5.95	(10-49)
	TH	T1-1H	1	8-300	8-300	10-200	25-100	4.95	(10-49)
		T9-1H	9	2-90	2-90	3-75	6-50	5.45	(10-49)
		T16-1H	16	7-85	7-85	10-65	15-40	5.95	(10-49)
	TMO	TMO1-1	1	.15-400	.15-400	.35-200	2-50	4.95	(10-49)
		TMO1.5-1	1.5	.1-300	.1-300	.2-150	.5-80	6.75	(10-49)
		† TMO2.5-6	2.5	.01-100	.01-100	.02-50	.05.20	6.45	(10-49)
		† TMO4-6	4	.02-200	.02-200	.05-150	.1-100	6.45	(10-49)
		TMO6-1	6	.3-200	.3-200	.5-150	5-50	6.45	(10-49)
		TMO9-1	9	.15-200	.15-200	.3-150	2-40	6.45	(10-49)
		TMO1.6-1	16	.3-120	.3-120	.7-80	5-20	6.45	(10-49)
D 	T	T2-1	2	.025-600	.025-600	.05-400	.5-200	3.45	(10-49)
		T3-1	3	.5-800	.5-800	.2-400	—	4.25	(10-49)
		T4-2	4	.2-600	.2-600	.5-500	.2-250	3.45	(10-49)
		T8-1	8	.15-250	.15-250	25-200	2-100	3.45	(10-49)
		T14-1	14	.2-150	.2-150	.5-100	2-50	4.25	(10-49)
	TMO	TMO2-1	2	.025-600	.025-600	.05-400	.5-200	5.95	(10-49)
		TMO3-1	3	.5-800	.5-800	2-400	—	6.95	(10-49)
		TMO4-2	4	.2-600	.2-600	.5-500	2-250	5.95	(10-49)
		TMO8-1	8	.15-250	.15-250	.25-200	2-100	5.95	(10-49)
		TMO14-1	14	.2-150	.2-150	.5-100	2-50	6.75	(10-49)
E 	FT	FT1.5-1	1.5	.1-400	.1-400	.5-200	1-100	29.95	(1-4)
	FTB	FTB1-1	1	.2-500	.2-500	.5-300	10-100	29.95	(1-4)
		FTB1-6	1	.01-125	.01-125	.05-50	.1-25	29.95	(1-4)
		■ FTB1-1-75	1	.5-500	.5-500	5-300	10-100	29.95	(1-4)

■ Denotes 75 ohm models

* Maximum Amplitude Unbalance
0.1 dB over 1 dB frequency range
0.5 dB over entire frequency range

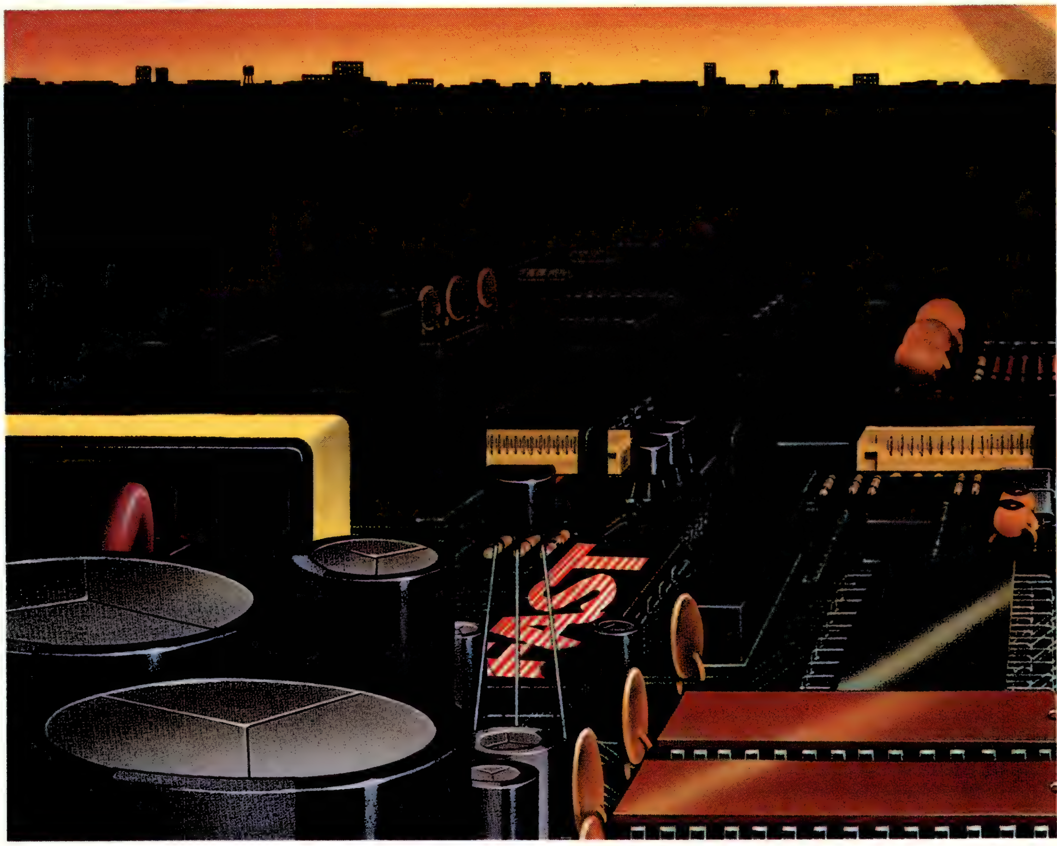
* Maximum Phase Unbalance
1.0° over 1 dB frequency range
5.0° over entire frequency range



C72-2 Rev. A

CIRCLE NO 16

Our FASTPLA devices help you get on board. FAST.



Isoplanar-Z, FAST (Fairchild Advanced Schottky TTL) and FASTPLA (Fairchild Advanced Schottky TTL Programmable Logic Array) are trademarks and the FAST logo is a registered trademark of Fairchild Semiconductor Corporation. ©1986 Fairchild Semiconductor Corporation.

Introducing FASTPLA™ – the newest addition to the high-performance FAST™ family.

By using FAST and FASTPLA parts together, you can expand your design horizons. Because they offer you the capability to implement your own architecture in your office with easily available design-aid software packages. And each time you program a FASTPLA circuit, you create another FAST device.

Now your designs can be quickly tried and evaluated, and you can make design changes by merely programming a new IC. This design flexibility encourages innovation. While lowering your design costs.

A FAST way to save on board space.

When FAST and FASTPLA devices are combined in the same design, board space is optimized. Your circuit complexity, parts count, and inventory are all reduced. Tests are minimized. And board failures become less likely.

FASTPLA parts – fast and flexible.

FASTPLA devices are the fastest TTL programmable logic arrays ever created, with a propagation delay of just 15 nanoseconds. FASTPLA ICs feature flexibility few other logic arrays can offer:

Programmable output polarity, for active high or active low implementation.

Power-up reset and three state for design simplicity.

And complete testability for higher reliability.

Guaranteed to get you to the market on time.

Using FAST and FASTPLA devices drastically cuts the time it takes to get your product on the market. From weeks or months to mere hours or days.

And FASTPLA circuits guarantee greater reliability and lower system costs, thanks to Fairchild's exclusive Isoplanar-Z™ technology (the vertical fuse and oxide-isolated process which gives you one of the highest programming yields in the industry).

For more information on FAST or FASTPLA parts, contact your local sales office or your nearest authorized Fairchild distributor. Or call The Fairchild Information Center at 1-800-554-4443.

FASTPLA™

And learn how easy it really is to get on board.

We're taking the high ground.

FAIRCHILD

A Schlumberger Company

CIRCLE NO 17

NO ONE LIKES

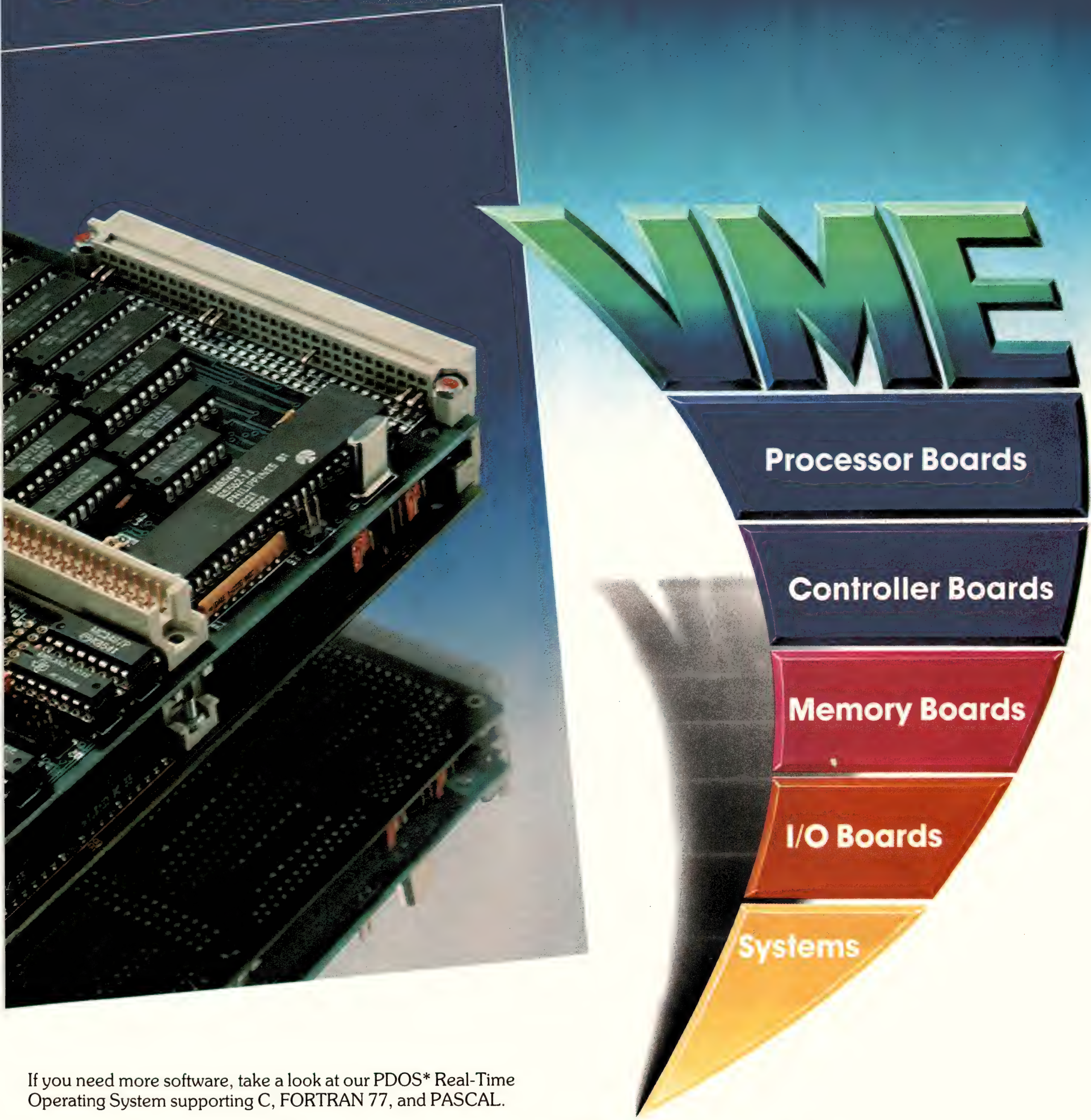
Your wait for 16 and 32 bit "WAIT STATE FREE" VMEbus CPU's is over.

Force Computers latest addition to its series of VMEbus CPU's features the popular 68020 at 16.67 MHz with zero wait states into 512 or 1024 KBytes of local RAM. Our design is so advanced that you will be able to accomodate speed improvements on the 68020 to 20 MHz without running into any "Wait States". NONE.

If your design calls for massive number crunching, we have good news for you. Our FPU runs at the same speed as the MPU.

If you don't like to wait, use our free advanced FORCEbug monitor. A one line assembler/disassembler for 68020 and 68881 with upload and download capabilities, self test, and memory test is included. Free. Built-in macro commands and benchmarks will give you the first glance at true 32 bit "NO WAIT STATE" performance.

TO WAIT !



If you need more software, take a look at our PDOS* Real-Time Operating System supporting C, FORTRAN 77, and PASCAL.

Or, if you think that 16 bit will do it for you, get your hands on our brand-new CPU-5 family with "NO WAIT STATE" performance at 12.5 and 16.67 MHz into 128 KByte of local RAM and Floating Point support. Yes, 68000 at 16 MHz.

Force supports you with VMX on both CPU-20 and CPU-5 families. Both with 700 page manuals.

In-circuit and dynamic test including a 48 hour burn-in at 60 degrees C will give you the quality you are looking for.

Need more support?

Don't wait. Call our application support team toll free, 1-800 BEST VME. In California, 1-800-237-8862.

FORCE COMPUTERS®

the intelligent choice

FORCE COMPUTERS INC.
727 UNIVERSITY AVENUE
LOS GATOS, CA 95030
PHONE (408) 354-3410
TELEX 172465
TELEFAX (408) 395-7718

FORCE COMPUTERS GMBH
DAIMLERSTRASSE 9
D-8012 OTTOBRUNN
TEL. (089) 60091-0
TLX 524190 FORC-D
TELEFAX (089) 6097793

FORCE COMPUTERS FRANCE
11, RUE CASTEJA
F-92100 BOULOGNE
PHONE (1) 6203737
TLX 206304 FORCF
TELEFAX (1) 6213519

---

*PDOS is a trademark of Eyring Research Institute.

USA Readers Circle No. 18

Non-USA Readers Circle No. 163

SIGNALS & NOISE

12-bit A/D converter converts in 5 μsec

Dear Editor:

I read with interest Jim Williams' article "Build your own A/D converter for optimum performance" (EDN, March 20, pg 191). Mr Williams is incorrect in stating that, "At the 12-bit conversion level, the fastest monolithic devices spec conversion times of approximately 10 μsec." The AD7572 from Analog Devices is a 12-bit, monolithic CMOS A/D converter with a maximum conversion time of 5 μsec.

Perhaps Mr Williams is not aware of the existence of this part. In any event, I would like to set the record straight and to point out that fast monolithic A/D converters are available—although they're not yet as fast as 2 μsec—at prices that make them competitive with any home-made solution.

Sincerely yours,
Trevor Emmons
Senior Marketing Engineer
Analog Devices
Norwood, MA

High-performance IC tester

Dear Editor:

In his Special Report on benchtop component testers (EDN, March 20, pg 94), Charles H Small mentioned that Logue-McDonald's Model 323i is a functional tester for digital ICs. This statement may lead EDN's readers to believe that such testing is all the 323i can do. In fact, the product is a high-performance dc-functional and an ac full-parameter tester.

Sincerely yours,
Bill Banger
President
Logue-McDonald Automation Inc
Spokane, WA

Addendum

It has come to EDN's attention that Science Applications International Corp, listed in the manufacturers' box accompanying the article "VME Bus and Multibus II industrial I/O boards" (EDN, March 6, pg 191), sold its VME product line in January 1986. The new owner of the product line, formerly Science Application's VME Microsystems Div, is now called VME Microsystems International Corp. Its address is 112021N South Memorial Parkway, Huntsville, AL 35804. Phone (205) 880-0444.

Move the circuit diagrams

In P Gascoyne's Design Idea "Pulse generators offer improved performance" (EDN, February 6, pg 158), the schematics for **Figs 1** and **4** were inadvertently transposed during the editing process. We apologize for any confusion the error may have caused.

TUSONIX

If you're looking for "special"
Ceramic Capacitors or EMI Filters

They're probably "standard" at Tusonix
. . . ready for fast delivery

We've been manufacturing quality ceramic capacitors for 50 years . . . and today Tusonix is the most versatile ceramic capacitor manufacturer in North America. For example, Tusonix manufactures a full line of plate, disc, tubular, high voltage, feed-thru, stand-off, and trimmer ceramic capacitors . . . most of which have QPL approval. Plus, we produce a wide range of technical ceramic dielectrics — AND EMI filters with QPL approval.

There's no need to go further than Tusonix for your next capacitor or filter buy. Write TODAY for catalog 8586 . . . or please call us at 602-744-0400.

TUSONIX
P.O. Box 37144, Tucson, AZ 85740-7144
602-744-0400 Telex: (RCA) 299-640

CIRCLE NO 19

MIL-M-38510.

4SS-5139

SPRAGUE IS CERTIFIED FOR PICs.

Sprague Power Integrated Circuits are processed on a DESC certified production line to MIL-M-38510. QPL and compliant devices are screened to Class B assurance levels of MIL-STD-883C. These high-voltage and high-current PICs provide excellent answers as peripheral power drivers for displays, motors, solenoids, relays, printers, and heaters. Long recognized as *the* leader in power ICs, Sprague will continue to supply selected components on the Qualified Parts List.

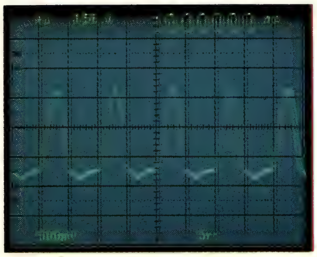
Sprague Electric Company, a Penn Central unit, World Hdqtrs., Lexington, MA.

For applications assistance, call Walter Sullivan at 617/853-5000. For our Brochure WR-198, write to Technical Literature Service, Sprague Electric Company, 41 Hampden Road, P.O. Box 9102, Mansfield, MA 02048-9102.

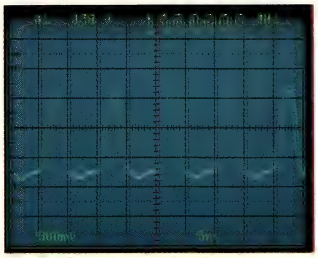
SPRAGUE
THE MARK OF RELIABILITY

CIRCLE NO 20

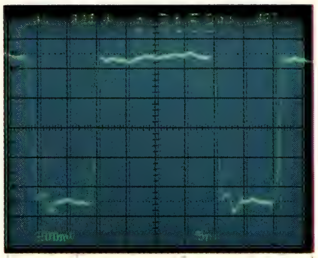
SIXTEEN TOUGH ASSIGNMENTS.



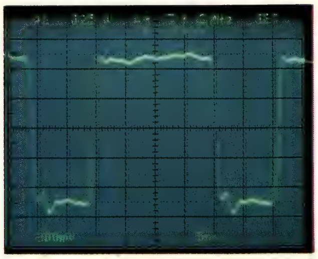
A period measurement is made on a 100 MHz clock using the extended accuracy and resolution of the Counter/Timer/Trigger in the 2465 DVS.



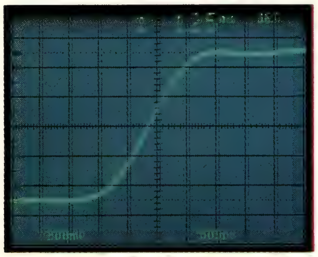
A frequency measurement is made with the same high precision. Simply press two buttons, and the period measurement on the left is converted to frequency.

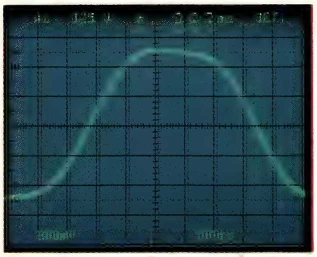


Short time intervals can be measured most accurately with the easy-to-use time cursors. They also make quick work of longer intervals, with 1% accuracy.

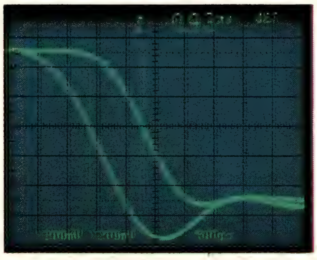


Calculated frequency takes only seconds. The time cursor measurement on the left can be converted to frequency with push-button ease and 1% accuracy.

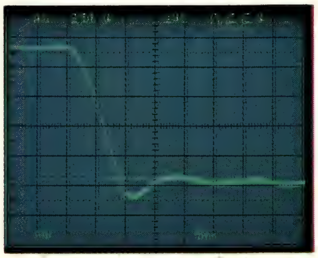




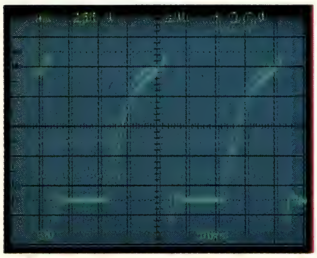
This fast-pulse rise time is nearly that of the scope. The 2465 achieves maximum bandwidth with minimum waveform aberrations. This level of pulse response ensures that **pulse width** and amplitude measurements on fast waveforms (above) truly reflect conditions in a circuit under test.



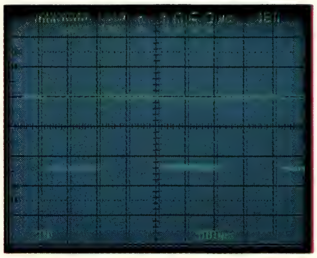
Propagation delay measurement accuracy is assured by built-in propagation delay matching. Delay between Channels 1 and 2 can be corrected to the probe tip.



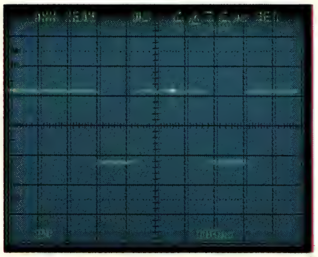
Overshoot and ringing measurement accuracy requires flat response in a probe/oscilloscope system. Tek probes and scopes are designed to work together.



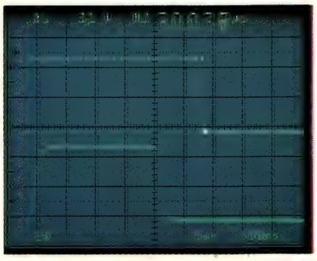
Logic-level violations can be spotted quickly on a TTL waveform (above) with measurement cursors set to define logic-level boundaries.



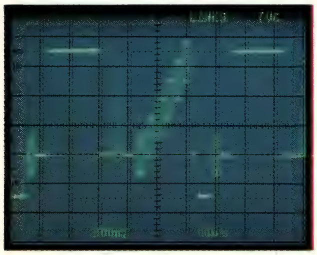
The Word Recognizer (with a binary word) is used to pick out a pulse train in a data stream. The time cursors measure pulse train duration.



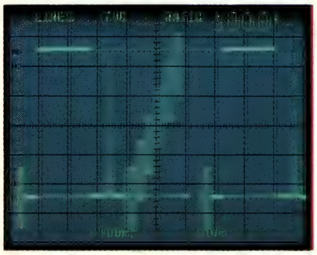
Identify a word position. The Word Recognizer (in HEX) is intensifying a word position and measuring delay relative to a waveform on another line.



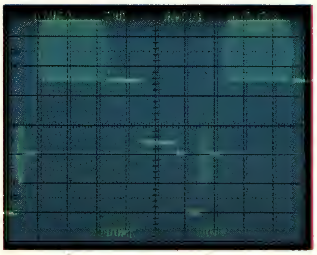
Delayed sweep is used to expand the last pulse in a pulse train. The intensified zone identifies the expanded pulse position.



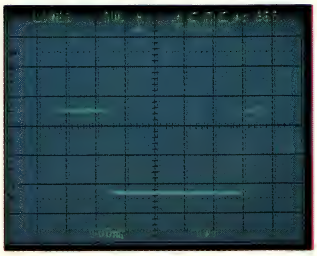
TV line trigger in the 2465 DVS displays a full-field composite test signal. The built-in TV clamp circuit removes hum and tilt on the ac-coupled video.



Calibrate cursors in IRE units with variable attenuation. Blanking level to reference white level is defined as 100 IRE units in NTSC video.



Burst amplitude should be 40 IRE units in NTSC video. The cursors quickly measure other waveform amplitudes. Field triggering checks any line.



Sync width and blanking are common, easy-to-make timing measurements. Accurate time measurements can be made anywhere in a video system.

Copyright ©1986, Tektronix, Inc. All rights reserved. PMA-628

FIVE EASY ANSWERS.
THE TEK 2400 SERIES.

You can simplify even the most complex measurements with the performance and convenience of Tek's 2400 Series family. No other portable scopes meet such diverse requirements in research and design, manufacturing and service.

The 300 MHz 2465 and 150 MHz 2445 are at the foundation of the family. They include all the features that set a new high performance precedent. For example, standard delayed sweep Δ-Time to 0.5% accuracy. Coupled sweep speeds to 1 ns/div in the 2445 and 500 ps/div in the 2465 for tough timing measurements. And four-channel capability for observing and troubleshooting logic circuits.

Best of all, these standalone scopes are proof that powerful capability doesn't have to be complicated. Time and voltage cursors for fast and easy measurements, CRT readouts showing waveform parameters and front panel settings, and simplified trigger operation make these scopes a pleasure to use.

Features	2445	2465	2465 CTS	2465 DMS	2465 DVS
Bandwidth	150 MHz	300 MHz	300 MHz	300 MHz	300 MHz
Max. Sweep Speed	1 ns/div	500ps/div	500ps/div	500ps/div	500ps/div
Accuracy; Vert/Hor	2%/1%	2%/1%	2%/1%	2%/1%	2%/1%
Vertical Sensitivity	2 mV/div	2 mV/div	2 mV/div	2 mV/div	2 mV/div
Trigger Freq. Range	250 MHz	500 MHz	500 MHz	500 MHz	500 MHz
Trigger Modes	Auto Level, Auto, Norm, Single Sequence				
Counter/Timer/Trigger/Word Recognizer	*	*	STD	STD	STD
DMM	*	*	N/A	STD	STD
Video/TV	*	*	N/A	N/A	STD
Four P6131 Probes	*	*	STD	STD	STD
GPIB	*	*	STD	STD	STD
Rackmount	*	*	*	*	*
Warranty	3-year on parts and labor, including CRT				
Price†	$3590	$5350	$7150	$8400	$9200

Software	
TEK GURU for IBM PC/XT/AT and 2445/65/GPIB	$595
EZ-TEK 2400 for TEK 4041 and 2445/65/GPIB	$400

*Configurable only at time of order. Additional cost required.

†Prices subject to change without notice.

IBM PC is a registered trademark and AT and XT trademarks of International Business Machines Corporation.

Three specially configured, specially priced Special Editions offer enhanced measurement capabilities for both systems and stand-alone use. At the top is the 2465 DVS with integral GPIB interface, DMM, Counter/Timer/Trigger/Word Recognizer, and Video measurement capabilities. Easily the most powerful portable ever developed.

The 2465 DMS and 2465 CTS are special editions with different feature sets. The 2465 DMS provides all the capabilities of the DVS except Video. The 2465 CTS provides all the features of the DVS except Video and DMM.

Call your Tek Sales Engineer for a demo today! Or call the Tek National Marketing Center toll-free, 1-800-426-2200. In Oregon, call collect, (503) 627-9000.

Tektronix®
COMMITTED TO EXCELLENCE

CIRCLE NO 21

Do-It-Your

It's easy. All you need is our PLDS2 desktop development system. An IBM PC (or compatible). And a project that asks for a custom logic circuit. Fast.

You'll set up the system in just a few minutes. Just snap a board into your PC's slot. Plug in the EPLD programmer. Slide the software into a drive. And you're on your way. No mainframe hassles. No sharing your workstation.

With the PLDS2, you'll be using a full-fledged CAE tool but you won't have to change any of your design habits. Our A+PLUS software lets you enter your design in a Boolean, netlist, state machine or schematic capture format. You can even mix formats.

The system will automatically fit your design into the target EPLD in minutes. Then let you program it in seconds. Giving you a working prototype that same day.

Finally, you can be assured your design will make it to silicon painlessly. Because there's a complete family of CMOS EPLDs (from 300 to 2100 gates). Including OTP plastic parts that make the cost of mass-production very attractive.

So get started in CAE. Call today to learn more about the PLDS2 development system, our family of EPLDs and the economics of doing it yourself.

Call (408) 984-2800

ALTERA

3525 Monroe Street
Santa Clara, CA 95051

A+PLUS is a registered trademark of Altera Corporation.
IBM is a registered trademark of International Business Machines Corporation.

Distributed in U.S. by Alliance, Lionex, Pioneer, Quality Components, Schweber and Wyle. In Canada by Future.

© 1986 Altera Corporation.

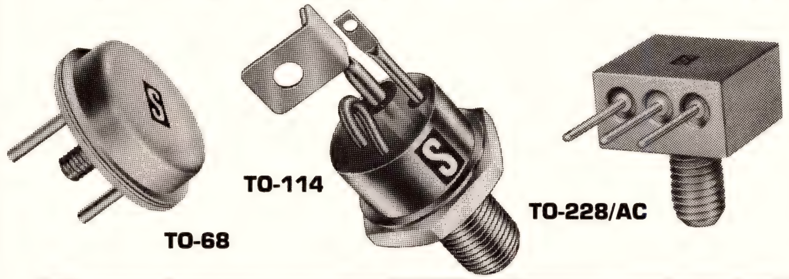
self CAE.

CIRCLE NO 22

120 AMP/400 VOLT FAST SWITCHING HI-REL POWER TRANSISTORS!

- SINGLE CHIP PLANAR CONSTRUCTION
- HIGH VOLTAGE UP TO 400 VOLTS
- HIGH CURRENT UP TO 120 AMPS
- LOW SAT VOLTAGES
- HIGH POWER DISSIPATION UP TO 700 WATTS

FIRST TIME AVAILABLE IN HI-REL PACKAGING!!



TYPE NO.	V_{CEO}(sus)	h_{FE} = 10 min @	V_{CE}(sat) max	θ_{JC} max °C/W	CASE
SDT99901	100V	120A	1.0V	0.25	TO-114
SDT99902	200V	100A	1.0V	0.25	TO-114
SDT99903	300V	70A	1.0V	0.25	TO-114
SDT99904	400V	60A	1.0V	0.25	TO-114
SDT99701	100V	120A	1.0V	0.5	TO-228/AC
SDT99702	200V	100A	1.0V	0.5	TO-228/AC
SDT99703	300V	70A	1.0V	0.5	TO-228/AC
SDT99704	400V	60A	1.0V	0.5	TO-228/AC
SDT99501	100V	120A	1.0V	0.35	TO-68
SDT99502	200V	100A	1.0V	0.35	TO-68
SDT99503	300V	70A	1.0V	0.35	TO-68
SDT99504	400V	60A	1.0V	0.35	TO-68

Solitron's new high voltage, high current planar power transistors offer fast switching capabilities for military and industrial applications including switching regulators, pulse-width modulated power supplies, push-pull inverters, power amplifiers, motor controls and robotics.

These unique devices are competively priced and available now from Solitron. Look over the specification chart. Then call our Sales Department toll-free 1-800-327-8462 for more information.

"The Problem Solvers"

Solitron
DEVICES, INC.

1177 Blue Heron Blvd., Riviera Beach, Florida 33404
(305) 848-4311 • TWX: (510) 952-7610 • TLX: 51-3435

CALENDAR

Introduction to Local Area Networks, Washington, DC. George Washington University, Continuing Engineering Education, Washington, DC 20052. (800) 424-9773; in DC, (202) 676-6106. July 21 to 22.

23rd Annual Conference on Nuclear and Space Radiation Effects, Providence, RI. David Bushmire, Publicity Chairman, Sandia National Laboratories, Organization 2151, Albuquerque, NM 87185. (505) 844-6572. July 21 to 23.

Inter-Noise '86 (International Conference on Noise Control Engineering), Cambridge, MA. Gayle Fitzgerald, Office of Special Events, Massachusetts Institute of Technology, Room 7-111, Cambridge, MA 02139. July 21 to 23.

Principles of RF and Microwave Circuits: Theory and Applications (short course), Santa Clara, CA. Besser Associates, 3975 E Bayshore Rd, Palo Alto, CA 94303. (415) 969-3400. July 21 to 23.

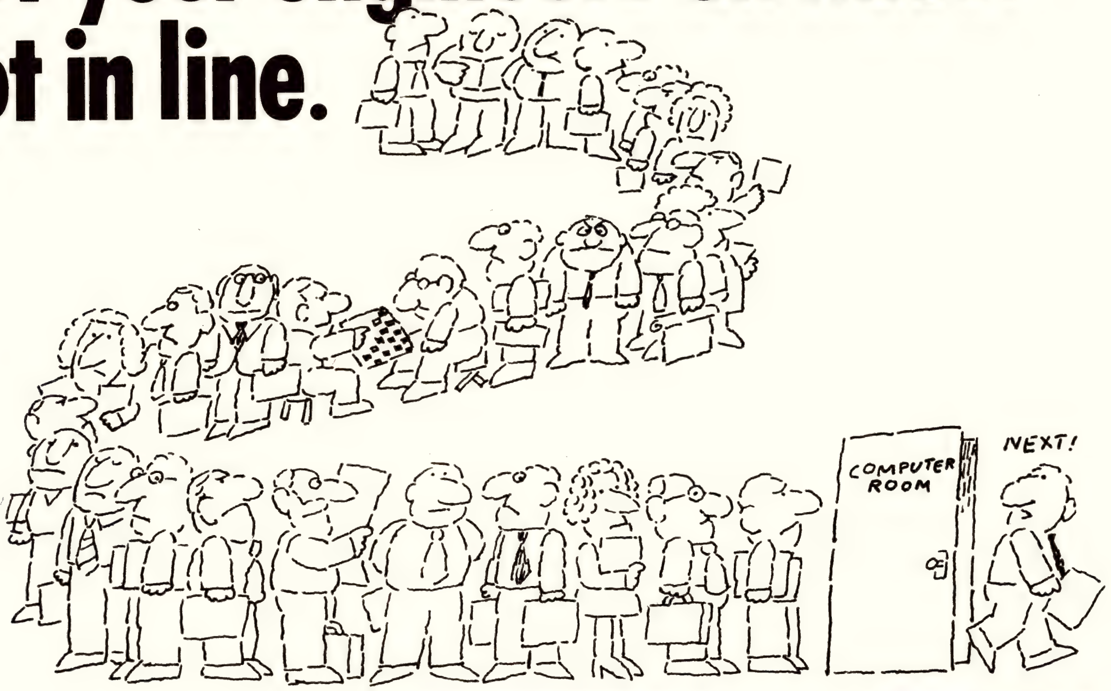
IBM PC Microcomputer Interfacing, Scientific Instrument Automation, and Control, Washington, DC. Center for Continuing Education, Virginia Tech, Blacksburg, VA 24061. (703) 961-5182. July 24 to 26.

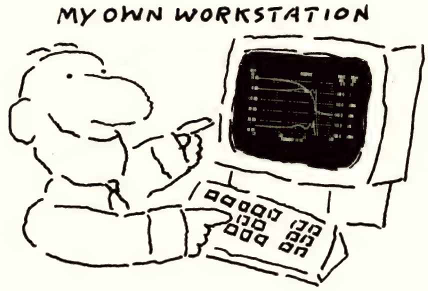
Summer Computer Simulation Conference, Reno, NV. Society for Computer Simulation, Box 17900, San Diego, CA 92117. (619) 277-3888. July 28 to 30.

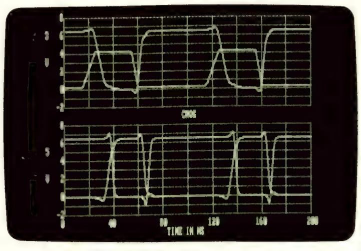
International Tesla Symposium, Colorado Springs, CO. IEEE Pikes Peak Section, Box 150, Colorado Springs, CO 80901. July 30 to August 3.

SIMS '86 (Symposium for Innovation in Measurement Science), Geneva, NY. Instrument Society of America, 67 Alexander Dr, Research Triangle Park, NC 27709. (919) 549-8411. August 3 to 8.

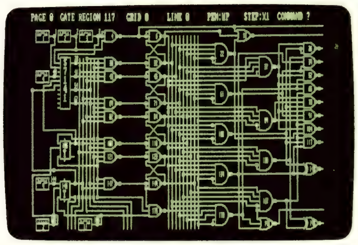
MICRO CAP and MICRO LOGIC put your engineers on line... not in line.







"Typical MICROCAP Transient Analysis"


PAGE 0 GATE REGION 117 GRID 0 LINE 0 PEN:UP STEP:X1 COMMAND ?

"Typical MICROLOGIC Diagram"

How many long unproductive hours have you spent "in line" for your simulation? Well, no more. MICROCAP and MICROLOGIC can put you on line by turning your PC into a productive and cost-effective engineering workstation.

Both of these sophisticated engineering tools provide you with quick and efficient solutions to your simulation problems. And here's how.

MICROCAP: Your Analog Solution

MICROCAP is an interactive analog circuit drawing and simulation system. It allows you to sketch a circuit diagram right on the CRT screen, then run an AC, DC, or Transient analysis. While providing you with libraries for defined models of bipolar and MOS devices, Opamps, transformers, diodes, and much more, MICROCAP also includes features not even found in SPICE.

MICROCAP II lets you be even more productive. As an advanced version, it employs sparse matrix techniques for faster simulation speed and larger networks. In addition, you get even more advanced device models, worst case capabilities, temperature stepping, Fourier analysis, and macro capability.

MICROLOGIC: Your Digital Solution

MICROLOGIC provides you with a similar interactive drawing and analysis environment for digital work. Using standard PC hardware, you can create logic diagrams of up to 9 pages with each containing up to 200 gates. The system automatically creates the netlist required for a timing simulation and will handle networks of up to 1800 gates. It provides you with libraries for 36 user-defined basic gate types, 36 data channels of 256 bits each, 10 user-defined clock waveforms, and up to 50 macros in each network. MICROLOGIC produces high-resolution timing diagrams showing selected waveforms and associated delays, glitches, and spikes—just like the real thing.

Reviewers Love These Solutions

Regarding MICROCAP . . . "A highly recommended analog design program" (PC Tech Journal 3/84). "A valuable tool for circuit designers" (Personal Software Magazine 11/83).

Regarding MICROLOGIC . . . "An efficient design system that does what it is supposed to do at a reasonable price" (Byte 4/84).

MICROCAP and MICROLOGIC are available for the Apple II (64k), IBM PC (128k), and HP-150 computers and priced at $475 and $450 respectively. Demo versions are available for $75.

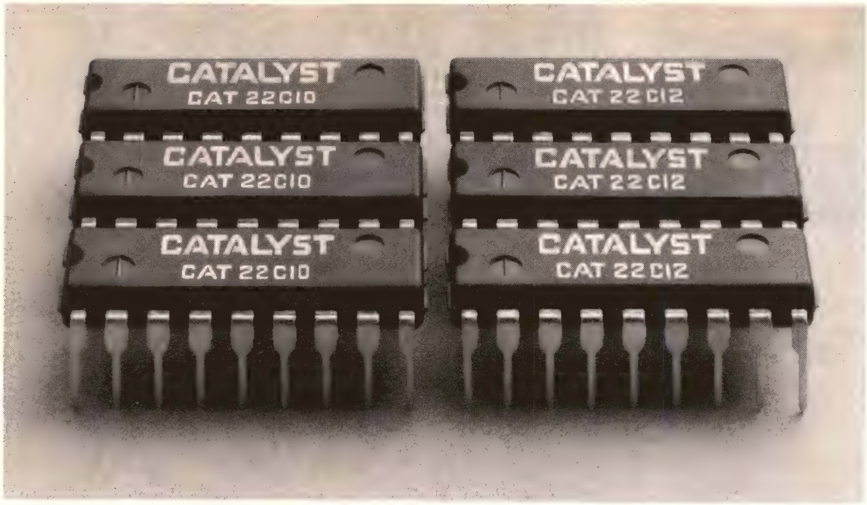
MICROCAP II is available for the Macintosh, IBM PC (256k), and HP-150 systems and is priced at $895. Demo versions are available for $100.

Demo prices are credited to the purchase price of the actual system.

Now, to get on line, call or write today!

Spectrum Software
1021 S. Wolfe Road, Dept. E
Sunnyvale, CA 94087
(408) 738-4387

CIRCLE NO 24



Two new non-volatile CMOS RAMS.

Quick, quantity deliveries...

....of 256 and 1024 Bit NVRAMS are now available through selected distributors and representatives of Catalyst Semiconductor, your fine new source of CMOS nonvolatile memory devices. Both devices are pin-to-pin compatible with Xicor parts X2210 and X2212.

The CAT22C10 NVRAM is a 256-bit device organized 64 x 4. Full static CMOS circuitry uses 40 mA in the active mode and standby current of 30 uA. Model CAT22C12, a 1024-bit device organized 256 x 4 uses 50 mA active current and 30 uA standby.

Both Feature:
☐ Write protect circuits. ☐ Automatic recall on power-up and power-down. ☐ RAM access times of 200, 250, and 300 ns. ☐ TTL/CMOS compatibility. ☐ JEDEC standard 18-pin, 300 mil package.

Single power supply (5V ± 10%). 3-state output. 200ns/min short store and 300ns/min recall pulses. False store protection below 3.5V. 10,000 nonvolatile Store cycles per bit.

Write or Call for our no-kidding data pack.

Please address Bob Simon, Director of U.S. Sales, Catalyst Semiconductor, 4051 Burton Drive, Santa Clara, CA 95054. Phone (408) 980-9144. FAX 408-980-8209. TWX 510-601-7631.

In Europe, contact Tekelec Airtronic, Cité des Bruyères, Rue Carle Vernet, 92310 Sèvres, France. Phone (1) 45-34-75-35.

CATALYST
SEMICONDUCTOR, INC.

CIRCLE NO 25

CALENDAR

PC Fab Expo, Boston, MA. PC Fab Expo, 1790 Hembree Rd, Alpharetta, GA 30201. (404) 475-1818. August 11 to 13.

Modern Power Conversion Design Techniques (short course), Seattle, WA. E/J Bloom Associates, 115 Duran Dr, San Rafael, CA 94903. (415) 492-8443. August 11 to 15.

Siggraph '86 (13th Annual Conference on Computer Graphics and Interactive Techniques), Dallas, TX. Smith, Bucklin & Associates, 111 E Wacker Dr, Chicago, IL 60601. (312) 644-6610. August 18 to 22.

3rd International Congress on Advances in Nonimpact Printing Technologies, San Francisco, CA. Society of Photographic Scientists and Engineers, 7003 Kilworth Lane, Springfield, VA 22151. (703) 642-9090. August 25 to 28.

8th Quartz Devices Conference, Kansas City, MO. Electronic Industries Association, Components Group, 2001 Eye St NW, Washington, DC 20006. (202) 457-4930. August 26 to 28.

Advanced Database Symposium, Tokyo, Japan. Information Processing Society of Japan, Kikaishinkou Kaikan, 3-5-8 Shiba Park, Minatoku, Tokyo 105, Japan. August 29 to 30.

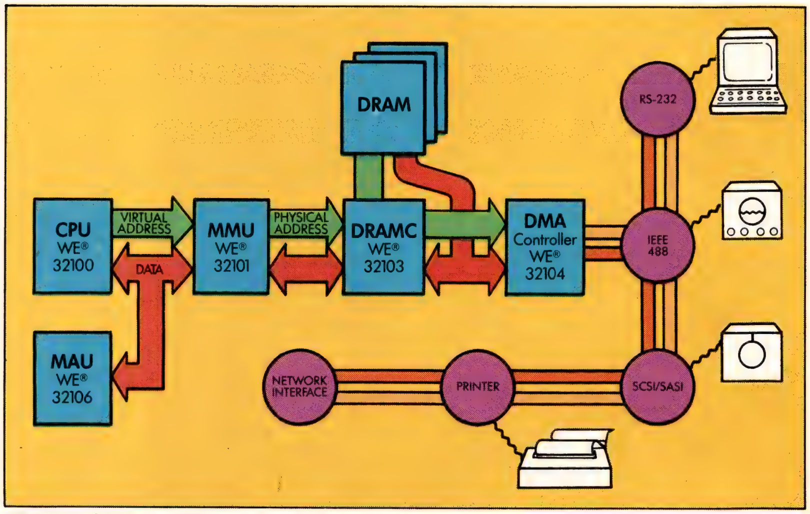
World Computer Congress, International Federation for Information Processing (IFIP '86), Dublin, Ireland. David Hyatt, Data Decisions, 20 Brace Rd, Cherry Hill, NJ 08034. (609) 429-7100. September 1 to 5.

Comdex/Australia, Sydney, Australia. Interface Group, 300 First Avenue, Needham, MA 02194. (617) 449-6600. September 2 to 5.

FEW REMEMBER WHO WAS SECOND ON THE MOON...
OR SECOND IN THE MARKET...

AT&T DOESN'T
THE MOON...JUST
AT BEING FIRST

Introducing the



100% complete, 100% TTL-compatible, 100% CMOS
AT&T Bell Laboratories doesn't do things half way.

The fastest shot.

How can AT&T make that kind of promise? Because AT&T offers you the first full 32-bit chip set with the performance you need.

A system that can actually cut your design time in half—with chips, not smoke.

Ready now with the world's most complete 32-bit chip set.

Check the schematic: AT&T is on board and ready to deliver the peripherals you need to meet your market window. It's the only chip set with CMOS every step of the way—and full TTL-compatibility.

The WE® 32100 Microprocessor is the heart of it. A second-generation CPU backed by five years of AT&T experience delivering 32-bit microprocessors. And by extensive experience in application of those processors to systems. Its high-speed instruction cache can store 64 32-bit words.

The Memory Management Unit (MMU) is also a second-generation component. It has 4 gigabytes of physical and virtual address space; lets you design on a paged and/or segmented basis; and includes on-chip miss processing.

The Math Acceleration Unit (MAU) conducts single, double, and 80-bit floating point arithmetic at rates exceeding one million Whetstone instructions per second. It can, for example, add or subtract in 1.4 microseconds. The MAU also performs 18-digit BCD arithmetic. And it meets full IEEE standards.

The Direct Memory Access Controller (DMAC), a full 32-bit peripheral, delivers the highest-speed transfers in the industry—including memory-to-memory and memory to-and-from a separate 8-bit peripheral bus.

The Dynamic RAM Controller (DRAMC) can be programmed to optimize your memory speed to the system.

With AT&T's total architecture, you won't waste time on glue logic, your device count will be lowered, your hardware design simplified.

And our system-wide CMOS means reduced power, less heat, greater device density, and fewer headaches. Absolutely nothing to slow your move from concept to product.

Optimized for UNIX System V, from the people who invented it.

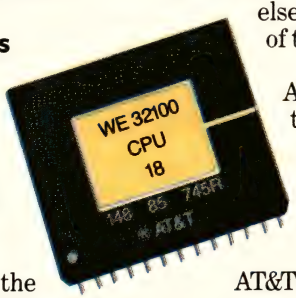
One of the most important things AT&T gives you is a hardware assist for the world's most productive

PROMISE YOU THE FASTEST SHOT IN THE MARKET.

AT&T 32-Bit UNIX™ Microsystem.

operating system: UNIX SystemV. Our system architecture is designed to mirror in hardware the model of a UNIX SystemV process.

We've developed today's most highly-optimized C language compiler, ensuring compact, high-performance code without manual optimization. Also available: compilers for high-level languages such as FORTRAN, COBOL, Pascal and BASIC. To keep you on the leading edge, the AT&T microsystem will continue to evolve with the UNIX SystemV standard.



Performance that has 'first-in-the-market' written all over it.

AT&T's 32-bit CPU is a high-performance microprocessor that gives you 2 to 3 MIPS at 14 MHz. And at an unprecedented 18 MHz, you get up to four times the power of an equivalent VAX.*

Our floating point operation speeds you along with a capability exceeding one million Whetstone instructions per second.

Our Memory Management Unit means you won't be burdened with miss processing or referenced-bit and modified-bit updating—this and other routine memory management functions are all handled by the chip.

Our Direct Memory Access Controller enables you to perform a memory-fill operation at a sizzling 23.9 megabytes-per-second.

Our Dynamic RAM Controller gives you two unique, performance-enhancing capabilities. It's the only DRAMC that supports double-word and quad-word memory fetches; the only one that can interface with a one-megabit DRAM.

Add to all of that an AT&T Evaluation Board that's today's fastest way to benchmark against all other microprocessors. It features zero wait state memory, resident assembly-level debugger, and CPU and Memory Management Unit with Math Acceleration Unit option.

Maybe somebody else gives you some of these features, but nobody else is ready to give you all of them. Now.

And nobody else matches AT&T's ongoing commitment to evolve and enhance system performance gracefully and compatibly.

Our Development System puts time on your side.

AT&T's Development System incorporates in-circuit emulation of the CPU and Memory Management Unit. And because it performs high-level language debugging, you'll know how your program will work before you commit to production.

Our Software Generation Programs operate with a UNIX SystemV host—a high-level language program development environment. It provides compilers no other system can match.

Across-the-board design and development support.

'Support' doesn't really cover it. At AT&T, we think of it more as a partnership. With Field Application Engineers who will work with you when and where you need it—from concept to product. With complete data sheets, manuals and application notes. With training sessions and seminars to get you up to speed on the how-to's of 32-bit development.

Make your move now to the new AT&T 32-Bit UNIX Microsystem. We can't guarantee you'll be first in the market. But we'll give you the fastest shot at it.

AT&T
The right choice.

Please rush me your Executive Briefing on the new AT&T 32-Bit UNIX™ Microsystem. EDN62686

Write: Joe McQuarrie, Sales Vice President,
AT&T, 555 Union Blvd., Allentown, PA 18103

Please include technical brochures for my design people.

Name ______
Title ______
Company ______
Address ______ City ______
State ______ Zip ______ Phone ( ) ______
Designer ______
Designer ______

Or call 1 800 372-2447. Telex: 9109973611.

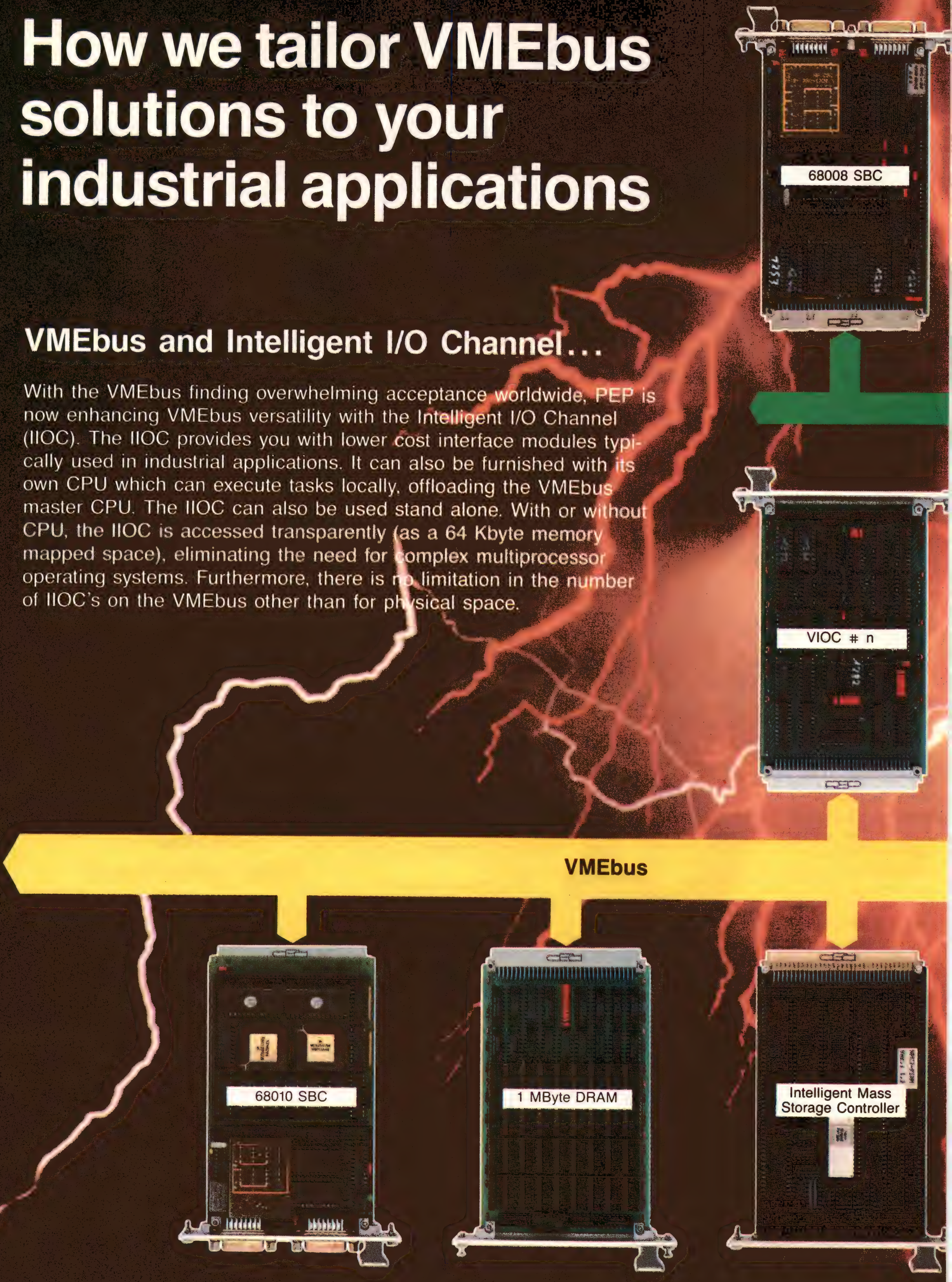
*VAX is a trademark of the Digital Equipment Corporation.
© 1985 AT&T Technologies, Inc.

CIRCLE NO 26

How we tailor VMEbus solutions to your industrial applications

VMEbus and Intelligent I/O Channel...

With the VMEbus finding overwhelming acceptance worldwide, PEP is now enhancing VMEbus versatility with the Intelligent I/O Channel (IIOC). The IIOC provides you with lower cost interface modules typically used in industrial applications. It can also be furnished with its own CPU which can execute tasks locally, offloading the VMEbus master CPU. The IIOC can also be used stand alone. With or without CPU, the IIOC is accessed transparently (as a 64 Kbyte memory mapped space), eliminating the need for complex multiprocessor operating systems. Furthermore, there is no limitation in the number of IIOC's on the VMEbus other than for physical space.



...all in Single Height format

PEP delivers both VMEbus and VME Related Products on the IIOC modules in a consistent, single height format. This gives you the physical and functional configuration flexibility ideally suited for industrial applications. In addition, single height modules are more reliable in harsh environments because of greater resistance to vibration, torsion and shock.

PEP Modular Computers, Inc., 600 North Bell Avenue, Pittsburgh, PA 15106
Phone: (412) 279-6661, (Tollfree): 1-800-228-1737 (outside PA),
1-800-255-1737 (inside PA), Telex 6711521, Teletax 412-279-6860

PEP Elektronik Systeme GmbH, Am Klosterwald 4, D-8950 Kaufbeuren
Phone: (08341) 8974, Telex 541233, Teletax (08341) 4022

Modular Computers®

CIRCLE NO 129

THERE'S A NEW CONTENDER IN THE MEMORY GAME.

When it comes to memory products, Samsung is coming on strong.

We're offering an ever-broadening line of products. We're building top-quality, industry-standard products of our own design, like our 64K and 256K DRAMs. And we're keeping costs down and volume up with production facilities internationally recognized as being among the most advanced in the industry. For example, Samsung is one of the few semiconductor companies fabricating 6-inch wafers in production quantities.

In fact, in the last four years, Samsung has made a $500 million commitment to developing and producing memory products, primarily for the U.S. market.

That means we're here to stay.

So if your current memory suppliers are less committed than you'd like, find out about Samsung. Just call your local Samsung sales representative or distributor to get our databook, samples and reliability report.

Samsung. We're on your side in the memory game.

Samsung Memory Products

	Density	Org.	Access Time (ns)	Mode	Packaging
DRAMs					
KM4164	64K		120/150	PAGE	DIP
KM41256	256K		120/150	NIBBLE	DIP, PLCC, ZIP
KM41257	256K		120/150	NIBBLE	DIP, PLCC, ZIP
EEPROMs					
KM2816A	16K	2K x 8	300/350	R/B	DIP
KM2817A	16K	2K x 8	300/350		DIP
KM2864A*	64K	8K x 8	250/300		DIP, PLCC
SRAMs					
KM6264*	64K	8K x 8	100/120/150		DIP/SOP

*Qual samples available Q2. Production quantities in Q3.

SAMSUNG
Semiconductor
5150 Great America Parkway,
Santa Clara, CA 95054
408-980-1630

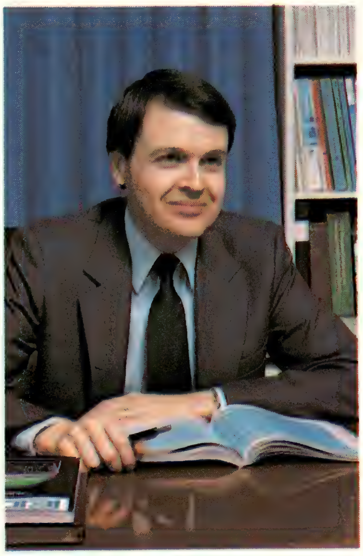
©1986 Samsung Semiconductor

CIRCLE NO 28

SAMSUNG SAYS SO.

EDITORIAL

Computers and CAE: Déjà vu



Remember what happened to the computer industry in the late '60s and early '70s? A whole raft of minicomputer companies sprang up to fill a need that wasn't being filled by mainframes. And remember what happened to the same industry in the early '80s? A host of microcomputer companies sprang up to fill a need that wasn't being filled by minis. Now, the raft of minicomputer companies has been reduced to a relative few, and the number of microcomputer companies is rapidly declining. After two intense periods of dynamic change, the computer industry is in a period of relative calm, perhaps awaiting the next market revolution.

In a sense of déjà vu, similar changes are occurring in computer-aided engineering. First came engineering workstations and then CAE hardware/software combinations from innovative system integrators. Both filled a need that traditional computer companies weren't filling. Now, CAE system integrators are supporting just a few "standard" workstations, thinning the ranks of would-be workstation manufacturers just as the ranks of computer manufacturers have been thinned. At the same time, they're putting more and more of their efforts into CAE software. Associate Editor Eva Freeman reports on these trends in her article that begins on pg 134.

Another parallel exists in software. Ten years ago, most computer software was custom (or at least very specialized) and very expensive. Now, you can buy powerful, general-purpose, widely available packages for a few hundred dollars or less. In CAE, the trend is the same. In his article that begins on pg 51, Associate Editor David Smith discusses how you can put together a semicustom-IC design system for practically peanuts.

Given these trends, will CAE continue in the way shown by personal computers? Will future product offerings be the CAE equivalent of WordStar (cheap, universal software) running on an IBM PC (a standard hardware platform)? The answer is yes, but not exclusively. To extend our analogy, cheap computers and software have brought word processing to secretaries, writers, and editors, just as inexpensive workstations and CAE software increasingly bring CAE into the realm of the average engineer. But word processors coexist with big, expensive, powerful, number-crunching systems, and cheap CAE systems can (and do) coexist with specialized, more powerful CAE systems. As PCs tie to mainframes in a corporate environment, low-end CAE systems need to tie to more capable systems in an engineering environment.

The bottom line, then, is that you still have CAE choices. Perhaps at some time in the future, some CAE system will be so well proven and so predominant that you will know, without a doubt, that it's right for you. In the meantime, though, you have to examine the choices. There's still no CAE equivalent to WordStar on a PC.

Gary Legg

Gary Legg
Editor

Anything's possible with Great Engineering.

To design your best semicustom ICs, come to GE and let yourself go.

Imagine, for a moment, what it would be like to have infinite semicustom IC resources at your fingertips.

And to explore all custom and semicustom options, before committing to the best.

That's exactly what it's like when you work with GE Semiconductor.

No matter which leading workstation you use—TEGAS,™ Daisy,™ FutureNet,® Mentor Graphics™ or P-CAD® —GE can supply design kits with the MSI and LSI functions you're familiar with. And with compatible outputs for fast GE prototyping.

You can attend GE training classes and experience the latest developments in silicon compilation, standard cells, gate arrays and workstation-based design. (While you're at it, you can evaluate GE capabilities. And get to know some very capable GE people.)

You can have your choice of a wide range of solutions. Use 4- and 2-micron and VHSIC-compatible CMOS gate arrays or standard cells. Work with our extensive hard, soft and flexicell macro library. And add RAM/ROM/2900 megacells.

With access to fast-turn Laserpath Quick-Chip™ prototypes and GE production, you can cut fabrication time on your gate array from the typical 6 to 8 weeks to under 1 week.

With our 2-micron and VHSIC-compatible silicon compilation technology, you'll have ultimate control over CMOS designs that push the limits of today's CAE tools.

All things considered, you'll spend more time working on solutions, less time worrying about support and design limitations.

Here's an example. Let's say you come to GE to design a gate array and decide, later, that you need a standard cell.

No problem. We've made the conversion of gate arrays into standard cells a pushbutton process. When one of our customers took us up on this recently, he not only improved his chip's speed, he reduced costs 50%.

By the way, we've also been working on being easier to work with.

That's why we're opening new Design and Application Centers from Minneapolis to Munich. To go along with our centers in Cupertino, CA; Research Triangle Park, NC; Boston; Dallas; Los Angeles; Paris and Basingstoke, U.K. Each is fully staffed with GE field application engineers.

To get in touch with one of our design centers or application engineers, call

1-800-4GE-SEMI, ext. 201.

(In NY State, 1-800-2GE-SEMI, ext. 201.)

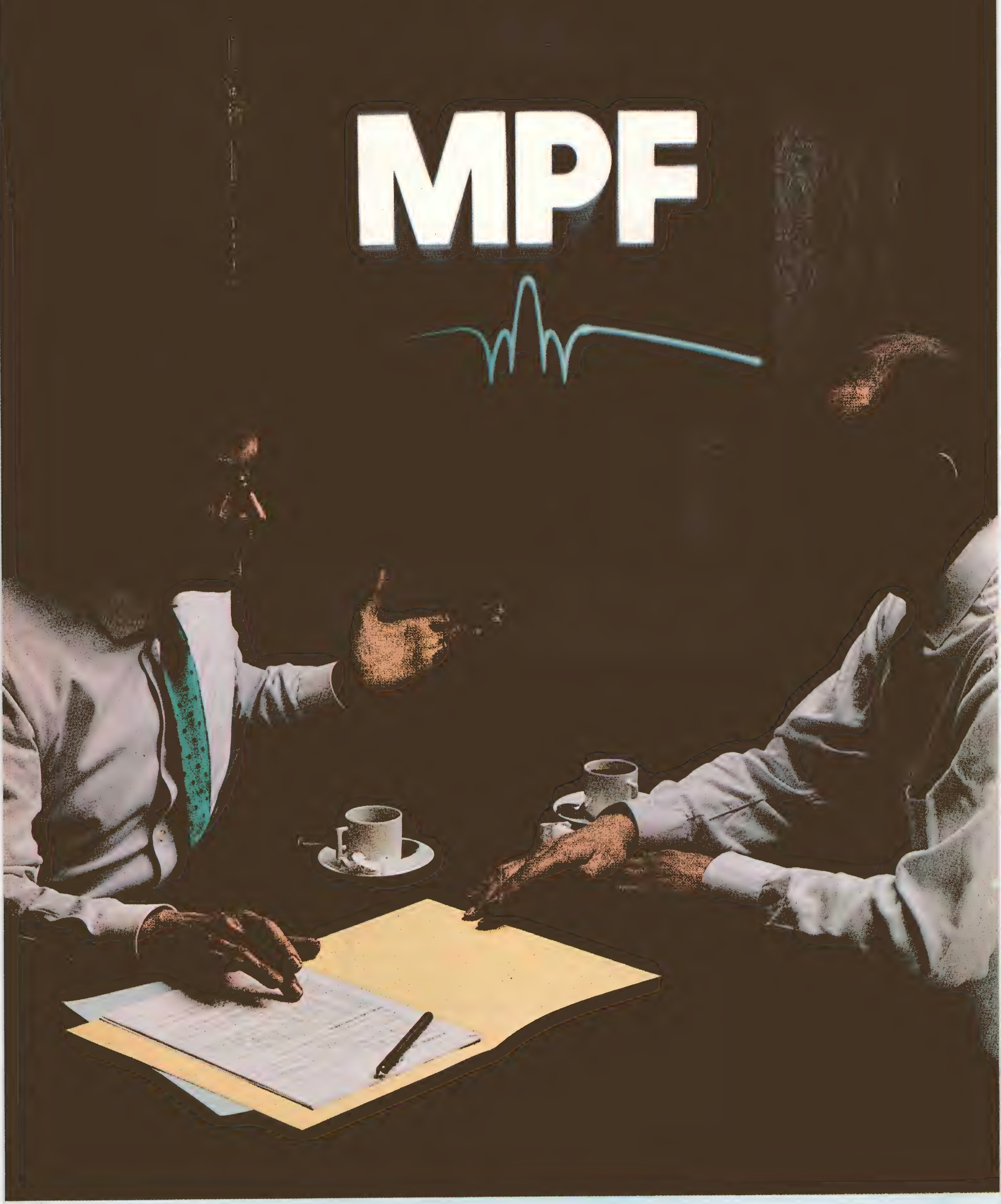
Then bring your design ideas to GE Semiconductor. And watch what happens when you let yourself go.

GE Semiconductor

CIRCLE NO 29

and are registered trademarks of General Electric Company, U.S.A.. Other computer and software names identified by ® or ™ are tradenames and/or trademarks of their respective manufacturers.

GE-118



MPF

France
PARIS VÉLIZY
Tél. (1) 39.46.97.19

Austria
WIEN
Tel. (222) 94.62.82

Bénélux
BRUXELLES
Tel. (2) 648.64.85

Brazil
SAO PAULO
Tel. (5511) 542.47.22.

Canada
MONTREAL
Tel. (1.514) 288.41.48

Denmark
COPENHAGEN
Tel. (01) 83.50.90

Far East Asia
HONG KONG
Tel. (3) 721.96.82

Finland
HELSINKI
Tel. (0) 75.04.14

W. Germany
MUNCHEN
Tel. (089) 78 790

Italy
MILANO
Tel. (2) 699.41.4

FILTERS WITHOUT THE STRAIN.

JUST ASK

Developing a custom filter for your application doesn't just take up valuable design time. It can put an unnecessary strain on your budget, too.

Fortunately there's an easy way to avoid these problems. The new Mask Programmable Filter from Thomson Semiconducteurs.

Our MPF is the smallest filter of its kind in the world. And whether your design calls for a standard DIL package or a chip carrier configuration, there's an MPF to suit your application.

What's more, since the MPF comes from Thomson Semiconducteurs, you can count on its reliability.

So whether your application is in aerospace, robotics, telecom, computers or the nuclear industry, take a little help from our MPF. And take the strain out of filtering.

THOMSON
COMPONENTS
SEMICONDUCTEURS

WE HAVE THE SOLUTION

5567 POLARIS

y
MA
(6) 639.02.48

Japan
TOKYO
Tel. (3) 264.63.48

Norway
OSLO
Tel. (02) 16.16.10

South East Asia
SINGAPORE
Tel. (65) 295.31.24

Spain
MADRID
Tél. (1) 405.16.15

Spain
BARCELONA
Tel. (3) 373.30.11

Sweden
STOCKHOLM
Tel. (08) 63.50.60

Switzerland
LIEBEFELD/BERN.
Tel. (31) 59.22.22.

United Kingdom and Ireland
BASINGSTOKE
Tel. (256) 29.155

U.S.A.
DALLAS
(214) 466.60.60

CIRCLE NO 31

The Technology Of Processing

"...leading-edge materials backed by complementary expertise."

Cris Belmont

Cris Belmont
Senior Technical Services Specialist,
Engineering Structural Foam Operation

"Every materials manufacturer would agree that properties and processing characteristics are two sides of the same coin. In my experience, however, few suppliers even come close to GE Plastics' processing involvement and investment.

Our Engineering Structural Foam product is an outstanding example. We pioneered engineering plastics foam technology and we've continued to lead the industry in the development of both advanced materials and processes. Right now, for instance, we're opening entirely new markets for structural foam with the dramatically enhanced surface appearance achievable through gas counterpressure molding. GE Plastics continues its investments to refine and qualify this process and assist customers in utilizing it cost-effectively. It's all part of GE Plastics' commitment to deliver leading-edge materials backed by complementary expertise."

Start a dialogue with GE Plastics. Call toll free (800) 845-0600 from anywhere in the U.S. or Canada and request our Processing Guides. It's the first step in putting GE Plastics' expertise to work for you.

GE PLASTICS
THE STRATEGIC SUPPLIER

Registered Trademark of General Electric Company

CIRCLE NO 32

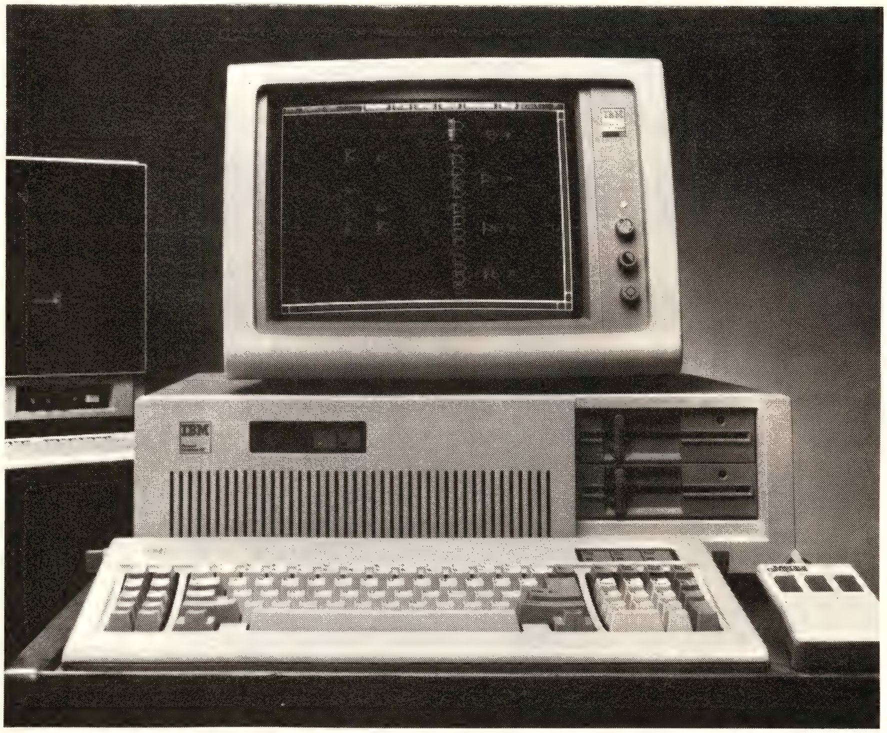
Design and simulate semicustom ICs on low-cost IBM PC-based design systems

David Smith, *Associate Editor*

Using an IBM PC/XT or PC/AT as a hardware platform, you can create a semicustom-IC design system for as little as $15,000. A typical PC-based system costs roughly half what an engineering workstation with similar functions costs. And although a PC doesn't provide the processing power of a workstation, you can use a PC-based system to create a logic design for an IC having as many as 3000 gates. You can enter your schematics and simulate your circuit on the PC, and in some cases you can even generate IC layout. For the most part, you'll probably use your PC-based design system as an inexpensive front end to a semicustom-IC vendor's layout and verification procedures.

Your PC-based design system will require a minimum of a few thousand dollars of hardware. It will require at least a PC/XT or PC/AT with 512k bytes of RAM, 10M bytes of hard-disk storage, some graphics capability, an 8087 μP (or an 80287 for the PC/AT), a dot-matrix printer, a mouse, and PC-based design software.

With this minimum configuration, your system may offer design throughput (the amount of design work you can finish in a given amount of time) that's comparable to that of a more expensive computer, even though the PC-based system will take longer to run individual programs. The advantage of using a PC—besides the fact that it costs relatively little—is that it's on your desk, it contains your design files and cell libraries, and you don't have to share it (see **box,** "High-performance PCs vs low-cost workstations.")



Your IBM PC can run IC-design software *(such as Mentor Graphics' schematic-capture and logic-simulation packages) that transforms the computer into a semicustom-IC design system. Some IC vendors supply free design software; software from CAE vendors costs as little as $8500.*

A typical PC-based CAE system uses a 640×200-pixel monochrome monitor or a 320×200-pixel color monitor. Higher-priced PC-based design systems feature more extensive graphics subsystems. The highest priced systems—such as Valid Logic Systems' $36,950 Validation Designer—use 1024×1024-pixel monitors.

Because a PC takes longer than a workstation does to perform large simulations, some PC-based CAE packages include coprocessor boards. Such a board includes a 32-bit μP (usually the NS32032) that runs simulations faster than the PC's CPU does. The 32-bit coprocessor can also run Unix, under which many CAE workstation programs run. This capability makes it easy for CAE vendors to adapt their workstation programs to the PC. A coprocessor board will add roughly $5000 to the price of your design system.

Further, the amount of RAM in your PC limits the size of the circuits you'll be able to simulate, so as you configure your system, keep in mind the size and kind of tasks you'll be requiring of it. For most logic-design and simulation purposes, you'll want the full 640k bytes of RAM that you can put into the machine.

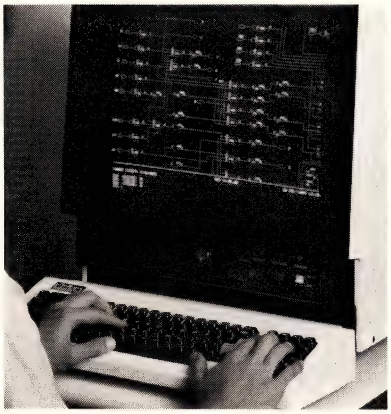
Simulation speed

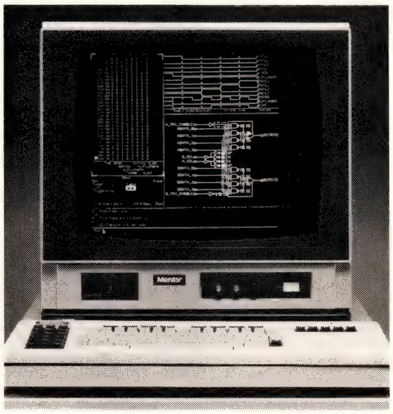
When you're choosing the PC for your system, you'll find that a PC/AT offers much faster simulation times than a PC/XT does. In

JUST OPENED

3000 NEW IC DESIGN CENTERS!

If you have a Daisy™ or Mentor,™ one of them is on your desk!





EASYGATE™ POWER.

Now, if you have either a Daisy or Mentor design station, you have one of the most powerful design centers in the field. Easygate is 50,000 lines of sophisticated software which, when superimposed on your Daisy or Mentor software, will allow you to design CMOS gate arrays, fully simulate their performance over voltage and temperature ranges, and automatically generate production test programs. And, we'll take your simulated net lists, and convert them to fully functional IC's in six weeks or less. *Think of it! All of the power of a factory supported design center with the efficiency and convenience of working at your own desk!*

UP TO 6200 GATES

With Easygate, you'll be designing on the Industry's most advanced double layer CMOS arrays, the IMI 6000 Series. Seven different arrays, with complexities to 6200 gates and up to 158 I/O connections are available. All are supported by a fully characterized macrocell library and completely automatic cell placement and routing methods. Also, all can be packaged in plastic or ceramic DIPS, LCC's or Pin Grid Arrays.

IMI 6000 SERIES

DESIGNATION	GATES	PADS	DRIVERS
IMI 6080	820	60	54
IMI 6140	1394	74	68
IMI 6176	1746	82	76
IMI 6270	2667	100	94
IMI 6330	3312	110	104
IMI 6430	4342	126	120
IMI 6620	6200	158	152

BLAZING PERFORMANCE

You can't buy a gate array that's built with a faster two micron CMOS technology than the one we use for the 6000 Series. That means you can design with minimal gate delays and toggle rates to 55 MHz over normal operating ranges. High speed performance with the low power consumption of CMOS!

EASY TO LEARN

If you're an electrical engineer, you can become an Easygate design expert in just one week. The IMI comprehensive training course will teach you how to design gate arrays using Daisy or Mentor. One week after you've completed the course, you'll be designing arrays at your desk.

ACT TODAY!

Data sheets describing Easygate and the 6000 Series are available **now.** Also, reservations for future training courses are being accepted. ***For more information, call 408-727-2280 today!***

International Microcircuits, Inc.

3350 Scott Blvd., Bldg. 36 ☐ Santa Clara, CA 95054 ☐ Telephone: 408-727-2280

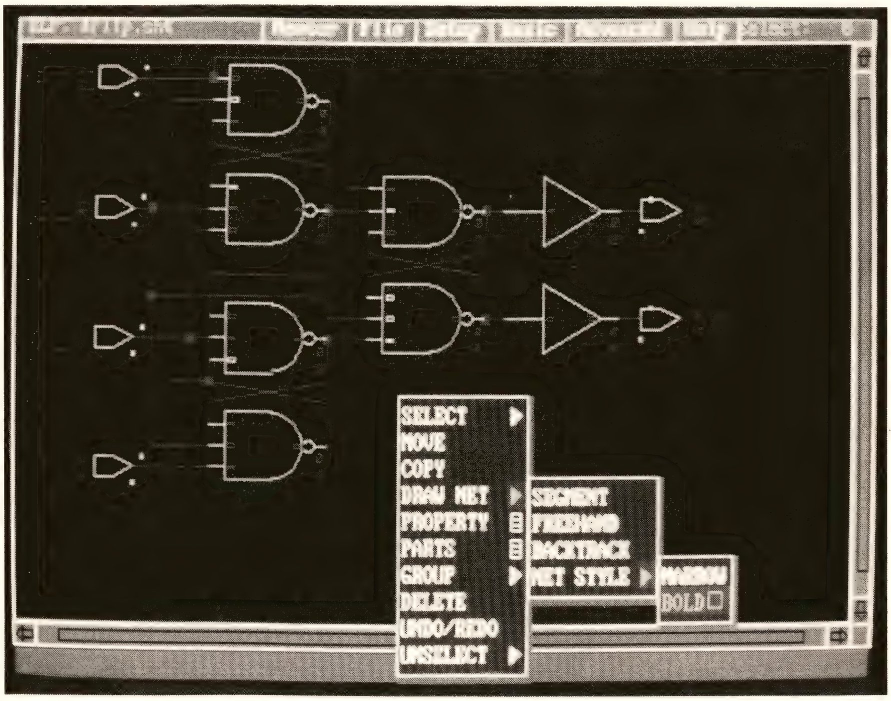
CIRCLE NO 33

fact, the PC/AT delivers two to three times the performance of the PC/XT, but the price of a complete PC/AT system is only 10 to 20% greater than that of a PC/XT system with similar features, so the PC/AT gives you more capability for your money.

GE Semiconductor found that its PC/XT program based on Personal CAD Systems' P-CAD required five minutes to link the hierarchical design files for a 2010-gate design, 33 minutes to prepare the files for simulation, and one minute and 42 seconds for simulation. For a 4690-gate design, those tasks required 14 minutes, 85 minutes, and two minutes and 15 seconds, respectively.

The PC/AT reduced those simulation times by half or even more: It took 12 minutes to prepare the design file for simulation and 34 seconds to simulate the 2010-gate design. The 4690-gate design required 45 minutes and 58 seconds, respectively, on the PC/AT.

Of course, even with a PC/AT, your system will simulate your circuits more slowly than a CAE workstation or mainframe computer would. For greater simulation speed, you could create your design on a PC-based system and perform the simulation on a workstation or a mainframe. These larger systems also let you perform advanced functions such as fault analysis.



To keep the price of your PC-based design system down, *you can use a standard 320×200-pixel color-graphics terminal, such as the one shown, which is running software from Mentor Graphics. High-resolution (1024×1024-pixel) systems can cost as much as $36,000.*

Design throughput

The actual design throughput you obtain, however, will depend on more than just which computer you run your simulations on. To simulate a PC-based design on a mainframe, you must transfer data from your design system to the mainframe you'll run the simulation on. Adding the data-transfer time to the actual simulation time will give you a more accurate idea of the system's design throughput.

For example, in a comparison of the simulation times of an IBM 3084 mainframe, a PC/AT-based design system, and a PC/XT-based system, the mainframe completed the simulation of a 1200-gate design running over 640 clock cycles in 19 seconds. The IBM PC/AT-based system finished the simulation in 3 minutes, 40 seconds, and the PC/XT-based system required 11 minutes, 24 seconds (**Ref 1**).

However, in this comparison, the mainframe was connected to the PC containing the design files over a 1200-bps interface. Transferring the simulation results from the 3084 to the PC took 20 minutes. So even though a mainframe can run simulations faster than can a PC-based system, the design throughput your PC provides may be comparable to the design throughput you obtain when you run your simulation on a mainframe.

PC-based design systems offer competitive design throughput even when compared to the standard engineering computer, the DEC VAX. For example, in a transient analysis, a VAX 11/780 was only twice as fast as a PC/XT with an 8087 coprocessor (**Ref 2**). In this example, the circuit analyzed was small (50 MOS transistors), and 200 time points were calculated. In cases in which many designers share one VAX, the PC can actually deliver results faster than can the VAX, because of the time needed to transfer files between computers.

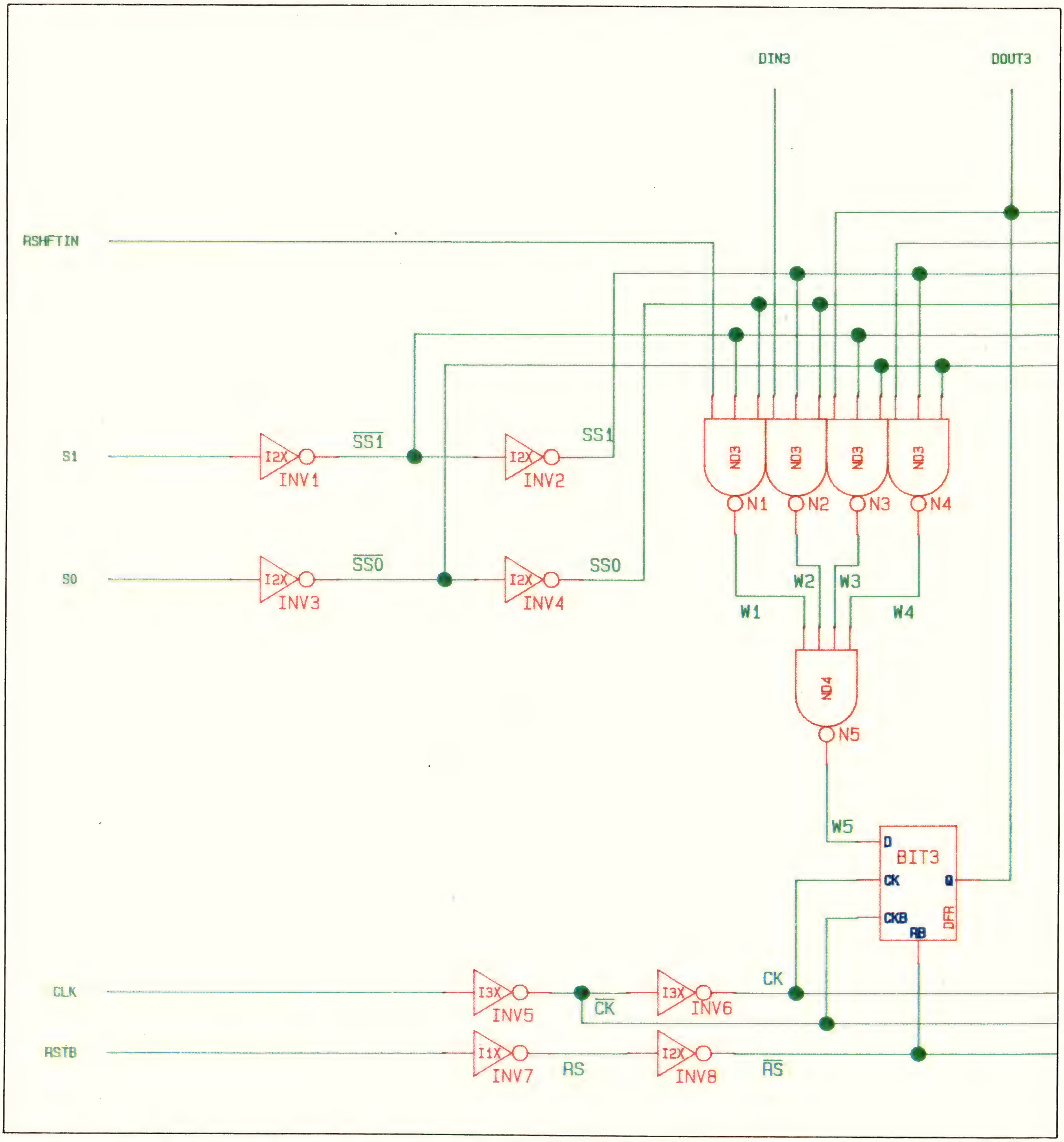
Choose CAE software

To obtain CAE tools for PC-based semicustom-IC design, you can go to either a semicustom-IC vendor or a CAE vendor. A semicustom-IC vendor provides inexpensive tools that can create designs only for its own ICs. Most semicustom-IC vendors prefer to leave design software to CAE vendors; instead, the IC vendors merely supply libraries of their cells for use with CAE vendors' products.

A CAE vendor, on the other hand, offers tools that let you create designs for ICs from a variety of semicustom-IC vendors. Because CAE vendors must support many types of circuits, their CAE tools are generally more expensive. CAE products from vendors that have established workstation lines are particularly expensive.

However, a few semicustom-IC manufacturers, such as GE Semiconductor and Gould AMI, supply proprietary design systems in addition to libraries for use with tools from CAE vendors. GE Semiconductor offers PC-based design packages that include Personal CAD Systems' P-CAD design software and GE's macro libraries. GE's CAE-1 schematic-capture package costs \$6140; CAE-2, which comprises CAE-1 and a simulation program, costs \$8995.

GE's CAE-2 package can simulate designs that contain as many as 5000 primitives. For highly asynchronous designs, which use relatively few primitives, the company estimates that CAE-2 can functionally simulate designs having as many as 3000 gates. For highly sequential designs, which use many



Schematic capture is the primary use *for PC-based design systems. This pen plot from GE Semiconductor shows the type of circuit documentation you can obtain with a PC-based system and a 4-color pen plotter.*

So, Is There a Real ASIC Second Source Setup in the Picture?

(Hint: Raytheon's RL7000 and LSI Logic's LL7000 are like . . .)

There's been a lot of wishful thinking about an active, genuine, semi-custom logic array second source. For very good reasons, but without a very good solution. Now, the right people, technology, and systems have been brought together. Raytheon and LSI Logic. It's happening.

☐ **Complete and identical:** Long term maintenance and bilateral updates of well-known LDS™ front and back end software. The same methodology. The same libraries, logic design, physical design, testing. Identical.

☐ **The Right Product:** According to the marketplace, 7000 Series is the leading choice in 2-micron HCMOS logic. Now, with a full-on second source, 7000 Series is the ASIC standard.

☐ **It's Happening:** Raytheon has over ten years of logic array experience. LSI Logic has over five. Real time, in the market, with real products.

☐ **Now:** You ought to can the apples and oranges routine. Call Raytheon for a real ASIC matchup.

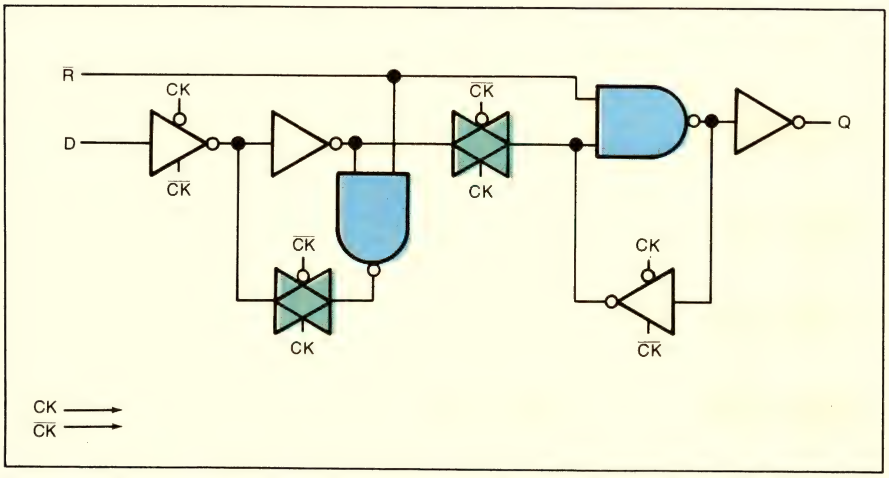
Raytheon Company
Semiconductor Division
350 Ellis Street
Mountain View, CA 94039-7016
(415) 966-7716

Access to the right technology

Raytheon

LL7000 and LDS are trademarks of LSI Logic Corp.

CIRCLE NO 34



***To model a D-type flip-flop** with an asynchronous reset line, semicustom-IC vendors use logic primitives such as inverters, 2-input NAND gates, and transmission gates. If your PC-based design system doesn't have such primitives in its database, the vendor will have difficulty modeling your semicustom ICs.*

primitives, the software can functionally simulate designs having as many as 1000 gates.

To emulate the variety of timing relationships between input and output signals, timing models require more primitives than do functional models. Therefore, if you do a timing simulation of a design made up mostly of registers, you may run out of memory after 300 registers. To solve this problem, you could break your design into sections and perform individual simulations on those sections.

Besides supplying libraries for use with tools from CAE vendors, Gould AMI makes its Sceptre program available to some customers. The program supports layout of the company's 2-μm standard-cell ICs, so it gives select customers more capabilities for using Gould AMI's semicustom ICs.

Two other semicustom-IC vendors, Intercept Microelectronics and Matra Design Systems, offer IC-design software at no charge to qualified customers who are serious about attempting a digital semicustom-IC design; the customers don't, however, have to sign an IC-development agreement in order to obtain the software.

You can use the design systems from these companies to design CMOS gate arrays and standard-cell ICs. The arrays can range in complexity to as many as 1900 gates and 62 I/O signals; the standard-cell ICs can contain the equivalent of 3000 gates. Because they tailor their software specifically for their own products, the two companies are able to include symbolic-layout capabilities in their design systems. Their software also allows you to extract parasitic loading caused by on-chip signal lines and to perform a post-layout simulation. The companies guarantee that your prototype chips will perform as your simulation predicts.

For linear semicustom-IC design, you can buy CAE tools from Micro Linear or Custom Arrays. These tools contain libraries and linear-simulation programs that you can use to create designs for the vendors' arrays. Custom Arrays' package also includes a layout program that lets you interconnect the components on its arrays; Micro Linear's does not.

Linear-IC CAE packages cost between $10,000 and $15,000, depending on the type of hardware you use (PC/XT or PC/AT). The PC/AT versions contain the same features as the PC/XT versions do, but the PC/AT versions run faster. Both versions provide libraries of analog cells such as op amps and comparators, and both include a circuit simu-

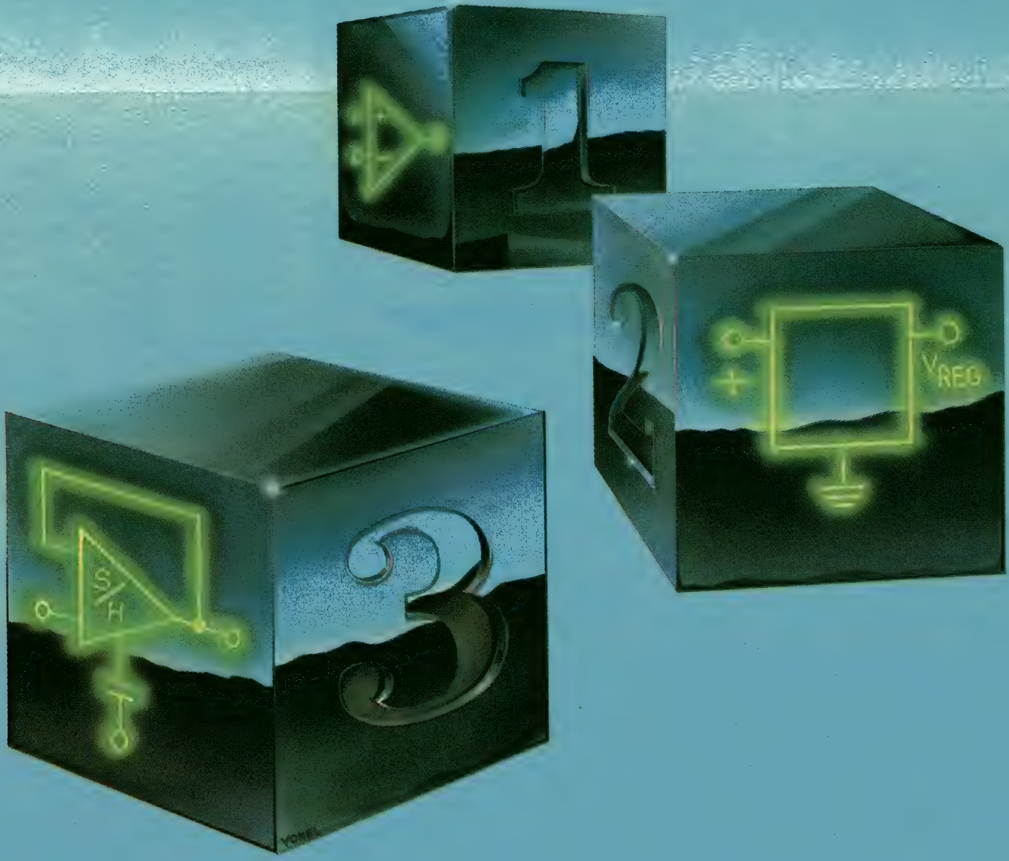
High-performance PCs vs low-cost workstations

If you can afford one of the higher-priced PC-based design systems, such as the $36,950 Validation Designer from Valid, you might consider buying a low-end dedicated workstation instead. You can get one of these more powerful computers for about $30,000. For example, you can get Apollo's 68020-based DN3000 workstation for $19,900 configured as Mentor's monochrome Capture Station (a schematic-capture system). Mentor's Idea Stations, which include simulation software and a DN3000, cost $30,700 each in quantities of 25.

Remember, however, that although a $30,000 workstation is a lot more powerful than a PC, the PC is a lot more flexible; it can be a lot more than just an engineering design tool. You can interface a number of hardware add-ins to a PC, and you can run thousands of business and engineering software packages on the computer.

And don't underestimate the importance of access to business software such as word processors; according to *Design Automation in Electronics*, an EDN research report, CAE users rank documentation as the most-used feature and the second most important feature for their CAE systems. You won't find as extensive a choice of software and hardware enhancements for workstations.

Analog Semicustom Design… It's never been easier.



Ferranti Interdesign opens a new dimension to system level designers of analog circuits. Now you can enjoy the benefits of cost and size reductions by designing directly onto silicon. It's never been easier. Never faster.

Announcing Macrochip —

Macrochip™ is a new analog semicustom IC design system that you can use on your Mentor workstation, IBM AT/XT or Analog Workbench. Predesigned and characterized analog building blocks such as op amps, comparators, and timers can be called up from the Macrochip library. Connect them together with active and passive components from the library and verify the design instantly at your own display terminal.

Once your design is complete, send us the disk and we'll return prototypes in as little as four weeks. If you prefer, you can do the placing and routing yourself.

A choice of nine Macrochip arrays lets you choose the chip that matches your circuit complexity without paying for unused silicon.

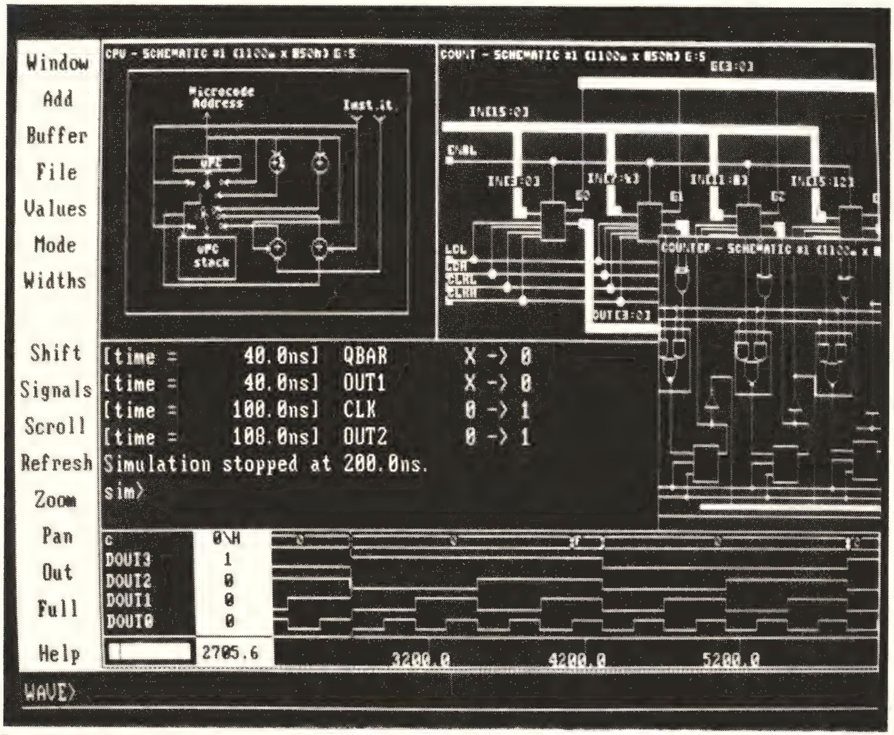
It all adds up to a new era in analog semicustom IC design. No time wasted with component level design. Analog circuit design onto silicon has never been simpler. And production parts start at $1 each in volume.

You can start using Macrochip today by calling your nearest Ferranti Interdesign Sales Office, Design Center. Or call us direct at (408) 438-2900 for brochures and more information.

Solutions in Silicon

FERRANTI
Ferranti Interdesign Inc

CIRCLE NO 35



```
[time =      40.0ns]  QBAR       X -> 0
[time =      40.0ns]  OUT1       X -> 0
[time =     100.0ns]  CLK        0 -> 1
[time =     108.0ns]  OUT2       0 -> 1
Simulation stopped at 200.0ns.
sim>
```

```
WAVE>
```

***Its multiple-windowing capability** distinguishes the Workview series of design tools from Viewlogic. With the $8500 Workview 500 software, you can perform schematic capture, waveform processing, document processing, simulation, and fault simulation.*

lator based on Spice. Micro Linear adds schematic capture and net-list generation; Custom Arrays requires you to enter your design into its system as a net list.

Software from CAE vendors

Unlike semicustom-IC vendors, CAE vendors typically have dozens of semicustom-IC libraries available for their tools, so when you buy software from a CAE vendor, you can choose from a number of IC vendors. The semicustom-IC libraries available for PC-based design systems comprise cells similar in function to discrete TTL and CMOS standard products, including latches, flip-flops, SSI-level logic, and I/O functions. Although many libraries don't include commonly used MSI-level cells, the design systems allow you to define groups of SSI cells as macros in order to create MSI-level functions.

CAE vendors are also likely to offer interfaces to other PC-based software products such as pc-board-design and documentation tools. Of course, you'll generally pay more for the added flexibility and functionality that a CAE vendor offers.

Futurenet and Personal CAD Systems offer the most widely available PC-based design systems. You can buy schematic-capture software from them for about $5000 that lets you create designs for chips from such semicustom-IC vendors as LSI Logic, NEC, Motorola, General Electric, Plessey, and National Semiconductor. You can add simulation software to Personal CAD Systems' P-CAD for $7500. The simulator for Futurenet's Dash design system requires a coprocessing board containing a 32-bit μP, which raises the added cost of simulation to $12,500. To start your design, you need to buy a library of cells from one of the IC vendors for between $500 and $1200.

A newcomer to PC-based design, Viewlogic Systems, provides the lowest priced semicustom-IC-design software that any CAE vendor offers. Its Workview 500 Series includes schematic capture, waveform processing, document processing, simulation, an EDIF interface, and fault simulation for $8500. Viewlogic also offers analog-design tools, and you can buy its complete analog/digital design system for $13,000 or less (depending on the options you choose). Workview uses libraries from Gould AMI and Custom Silicon.

Porting software to PCs

Companies that traditionally offered workstation-based CAE now offer PC systems as entry-level tools to their design environments. Daisy Systems, Mentor Graphics, and Valid Logic Systems offer software for the PC for schematic capture and logic simulation. In addition, these companies offer ports of their PC-based software to their proprietary workstations, so you can easily transfer designs from your PC-based system to these more powerful computers.

Daisy's Personal Logician software for the PC, for example, supports 76 semicustom-IC libraries from 32 vendors. You can also purchase a Personal Logician system that includes a PC/AT and the design software. You can design CMOS and bipolar gate arrays, CMOS and bipolar standard-cell ICs, and even GaAs arrays from Triquint Semiconductor (Beaverton, OR). Versions of the hardware/software package for the PC/AT offer Daisy's multitasking Unix (called DNIX) and as much as 3.25M bytes of RAM; the package's schematic-capture software costs $15,000.

Mentor's Entry Station package, which is available with or without a PC, offers schematic-capture software and an RS-232C connection to the company's Idea Series workstations. You transfer designs over an RS-232C link for simulation. With the $6900 software, you can design ICs for 37 semicustom-IC companies.

For its CAE tools, Valid offers libraries from 21 semicustom-IC vendors. The company's Entry Designer and Logic Designer systems,

PURE GENIUS

Circuit design at the speed of light.

Albert Einstein.
One of the world's greatest thinkers and physicists. To him, speed was a constant; the measure by which all other variables were compared. Quantum, a theory that subdivided energy. And his pure genius forever changed our world.

TRAX-PCB from Orcatech.
One of the world's great computer-aided circuit design systems. A quantum leap forward in productivity. Performance so fast that circuits almost gravitate from the screen. And the hardware driven autorouter in TRAX-PCB will truly revolutionize the way you design.

TRAX-PCB is more powerful than you can imagine. More affordable than you think. Call today for details and a demonstration.

Orcatech Inc.
28 Steacie Drive
Kanata Ontario Canada K2K 2A9
Telephone (613) 592-7650

ORCATECH

TRAX-PCB • For the great printed circuit designers of our time.

CIRCLE NO 36

which comprise PC/ATs and the vendor's software, cost $17,950 and $22,950, respectively. The Entry Designer AT/EG software lets you create schematics on the PC and transfer them to another Valid workstation. The Logic Designer AT/GX offers schematic capture, a high-resolution display (IBM's GX monitor), pre- and post-processing software, and optional interfaces to IBM computers and to Ethernet. In addition, Valid has recently introduced the Validation Designer system, which expands upon the capabilities of the Logic Designer by adding a logic simulator and a timing verifier. The Validation Designer starts at $27,950; depending on storage and display options, it can cost as much as $36,950.

Cell libraries

When you're choosing CAE software, be sure to consider how closely the cell libraries available for the PC match those of the semicustom-IC vendors' design systems. In order to get simulation results on your PC that are comparable to those the vendor will obtain on its workstation, you have to make sure that the cell library you use on your PC is very similar to the one the vendor uses.

Because of the PC's limited processing power, some vendors simplify the library models for the PC software they offer, so that you can maintain reasonable simulation speeds. Vendors can't always use identical models, because the PC-based programs don't always have basic circuit elements (ie, transmission gates) that vendors use to create their models. To understand how closely your simulation results will conform to the vendor's results, ask the semicustom-IC vendor how closely the cells for use on the PC correspond to those the vendor uses.

For more information . . .

For more information on the PC-based semicustom-IC-design systems described in this article, contact the following manufacturers directly or circle the appropriate numbers on the Information Retrieval Service card.

Custom Arrays Corp
525 Del Ray Ave
Sunnyvale, CA 94086
(408) 749-1166
Circle No 732

Custom Silicon Inc
600 Suffolk St
Lowell, MA 01854
(617) 454-4600
Circle No 733

Daisy Systems Corp
700 E Middlefield Rd
Mountain View, CA 94039
(415) 960-0123
Circle No 734

Futurenet Corp
9310 Topanga Canyon Blvd
Chatsworth, CA 91311
(818) 700-0691
Circle No 735

General Electric Semiconductor
Custom Integrated
Circuit Department
1 Micron Dr
Research Triangle Park, NC 27709
(919) 549-3377
Circle No 736

Gould AMI Semiconductors
3800 Homestead Rd
Santa Clara, CA 95051
(408) 246-0330
Circle No 737

Intercept Microelectronics
2890 Zanker Rd
San Jose, CA 95134
(408) 434-1987
Circle No 738

Matra Design Systems
2840 San Tomas Expressway
Santa Clara, CA 95051
(408) 986-9000
Circle No 739

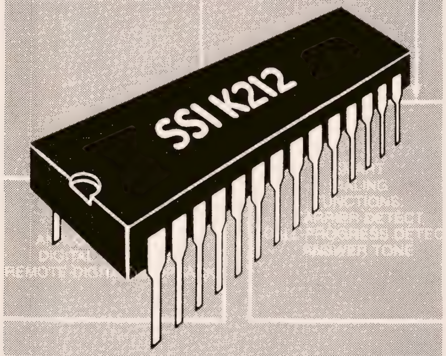
Mentor Graphics Corp
8500 SW Creekside Pl
Beaverton, OR 97005
(503) 626-7000
Circle No 740

Micro Linear Corp
2092 Concourse Dr
San Jose, CA 95131
(408) 262-5200
Circle No 741

Personal CAD Systems Inc
981 University Ave
Los Gatos, CA 95030
(408) 354-7193
Circle No 742

Valid Logic Systems Inc
2820 Orchard Park Way
San Jose, CA 95134
(408) 945-9400
Circle No 743

Viewlogic Systems Inc
33 Boston Post Rd West
Marlboro, MA 01752
(617) 480-0881
Circle No 744


SPOTLIGHT #19
IN A SERIES

NOW AVAILABLE-
THE ONE-CHIP
BELL 212A 1200
BPS MODEM

FEATURES:
- One-chip Bell 103/212A compatible modem IC
- Call progress detection and DTMF tone generator on-chip
- Easy to use 8-bit parallel bus (28 Pin DIP, QUAD) or optional serial bus for modem control (22 Pin DIP)
- Interfaces directly with 8051 or 8048 family of microprocessors
- Integrated analog and digital design provides exceptional performance
- Low power CMOS uses a single +10V supply

The SSI K212 is a complete Bell 212A modem on a single chip, and it incorporates all the primary functions needed for a typical intelligent modem. Included on a single chip are full Bell 103 and 212A operating modes, a call progress monitor, and a DTMF dialer. The device also has an 8-bit parallel bus for control of modem functions and will directly interface with the 8048/8051 family of low-cost micro controllers. A complete modem requires only the addition of the phone line interface and a control microprocessor.

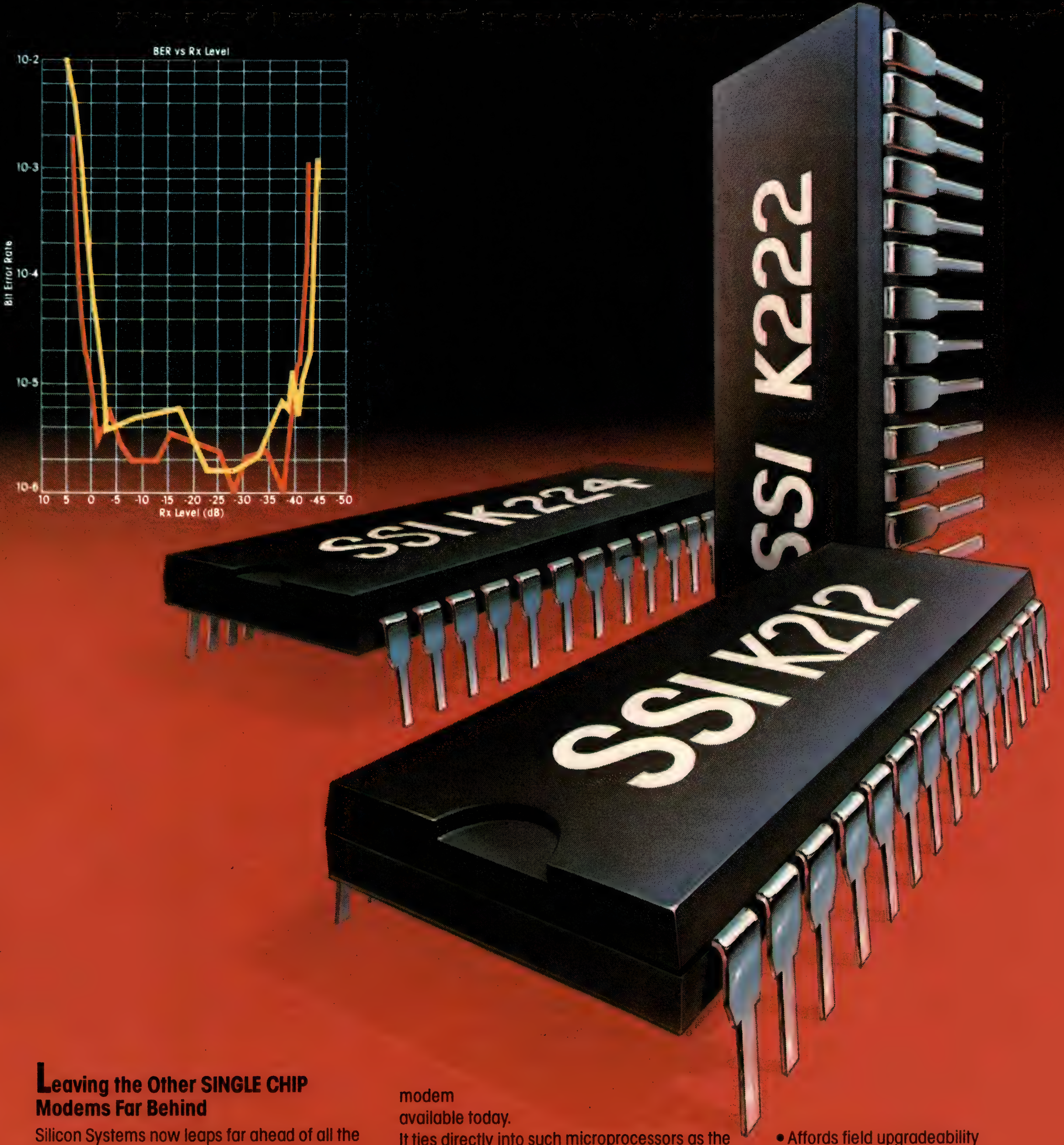
The one-chip K212 provides functions on a single chip which were previously only possible using many separate components. The new one-chip modem IC simplifies the design problem for users who are building modems for personal computer applications, and it is ideal for use in any self contained or integral modem system. The K212 provides exceptional performance under poor line conditions, and allows all Bell 212A operating modes.

For more information, contact: **Silicon Systems,** 14351 Myford Road, Tustin, CA 92680, **(714) 731-7110,** Ext. 595.

silicon systems
INNOVATORS IN INTEGRATION

CIRCLE NO 37

A NEW WORLD-CLASS MODEM FAMILY



Leaving the Other SINGLE CHIP Modems Far Behind

Silicon Systems now leaps far ahead of all the breakthrough claims of lesser chips with the only family of modem IC's with "upward design capability." This new SSI modem family covers the entire Bell and CCITT range of full-duplex split-band modem standards, from 300 to 2400 bits per second—and out-performs the competition. Now you can design your system hardware and software with this family in mind and enjoy the benefits of total compatibility between the three major single-chip modem IC's—the SSI K212, the SSI K222, and the SSI K224.

Start with the K212 and Move Up to the K222 or K224.

The SSI K212 is the finest Bell 212A one-chip modem available today.

It ties directly into such microprocessors as the 80C51 through a standard bus, without requiring a special controller chip. And if you are anticipating the need for a V.22/V.21 1200 bps modem IC or a V.22 bis 2400 bps, the SSI K222 or the SSI K224 will meet your needs. Design in an SSI K212 now and plug in an SSI K222 or a K224 later. Plug it into the same holes in the same hardware using the same software, and you can take advantage of the industry's only no-penalty upward-design feature in modem IC's.

Here's the Bottom Line to the User.

Here are just a few of the benefits of incorporating this family of IC modems into your products:

- Affords field upgradeability
- Family hardware/software compatibility
- Preserves hardware/software design investments
- Helps user get products to market faster
- Reduces user's inventory and design documentation requirements
- Basic feature sets available in firmware
- Demo boards available for characterization

Here's How to Get Started.

Call Silicon Systems now. Let us help you put the industry's finest family of standard modem IC's to work for you.

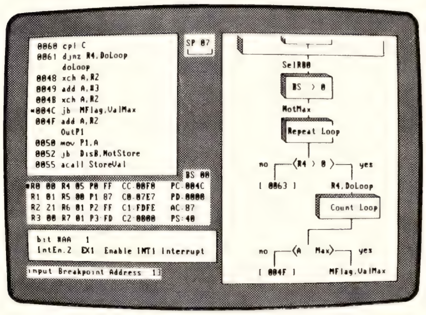
Silicon Systems, 14351 Myford Road, Tustin, CA 92680, (714) 731-7110, Ext. 595.

silicon systems
INNOVATORS IN INTEGRATION

Circle No. 41 for Career Information

Circle No. 2 for Product Information

IBM-PC based microcomputer development tools!



```
 0060 cpl C
 0061 djnz R4,DoLoop
      doLoop
 0048 xch A,R2
 0049 add A,#3
 004B xch A,R2
*004C jb  MFlag,ValMax
 004F add A,R2
      OutP1
 0050 mov P1,A
 0052 jb  DisB,NotStore
 0055 acall StoreVal
```

```
SP 07
BS 00
*R0 00 R4 05 P0 FF  CC-00F0  PC-004C
 R1 01 R5 00 P1 07  C0-07E7  PD-0000
 R2 21 R6 01 P2 FF  C1-FDFE  AC-07
 R3 00 R7 01 P3-FD  C2-0000  PS:40
```

```
bit #AA    1
IntEn.2  EX1  Enable INT1 Interrupt
```

```
input Breakpoint Address  1]
```

(8051 debug/simulator shown)

Your IBM PC can Assemble, debug and program (EPROM) code for these popular microcomputers:

	dBUG	XASM	PROG
8096	✓	✓	✓
8051	✓	✓	✓
8049	✓	✓	✓
7000	✓	✓	✓
8088	✓		✓
8085		✓	✓
320		✓	✓
Z8		✓	✓
	$595 except 8096 and 8088	$295	$245 Kit form

Step your code, watch registers & memory change, interrupts occur, stack push & pop. Flowgraph auto-documents code! You set breakpoints & register traps, count machine cycles, and scan source code and symbols. Single-key commands prompt for arguments if needed. Have more fun and get more done!

debug demo diskette and manual only $39.50

Cybernetic Micro Systems
P.O. Box 3000
San Gregorio, CA 94074 U.S.A.

(415) 726-3000 • Telex 171135 Attn: Cyber

CIRCLE NO 38

For linear simulations, however, most PC-based systems use PSpice, a version of Berkeley Spice adapted for the PC. PSpice is a subset of Spice that produces identical simulations to Spice for certain types of analysis; it can perform simulations of linear circuits having as many as 120 transistors. If you analyze your linear-IC design with PSpice, you'll get the same results that the IC vendor will obtain from Spice.

Timing simulation

To perform accurate timing simulation, you need a simulator that accurately models loading caused by interconnections between cells. Most semicustom ICs are fabricated in CMOS, so they're very susceptible to large loads. Often these loads result from the large fanout of critical signals such as clock and enable lines. You'll need to verify the performance of these signals, therefore, taking layout into consideration. To take layout into consideration, you must be able to assign an arbitrary value to any output signal on the macro. However, some PC-based simulators simply can't vary the loads on specific signals. If your simulator can't assign loads, you must depend on the IC vendor for your timing analysis.

Other capabilities enhance your system's ability to determine signal timing. Front annotation, which you can perform with Viewlogic's Workview System, allows you to assign maximum loads to critical nets; the IC vendor (Custom Silicon) adjusts the layout to keep signal loading under specified maximums. Worst-case multipliers, like those from GE Semiconductor, allow you to adjust timing output to reflect circuit performance under worst-case temperature and voltage conditions.

Vendors of PC-based CAE software don't support test generation and layout as well as they do logic entry and simulation. According to Burt Roffman, Futurenet's vice president of corporate development, there's no hardware-related reason why layout can't be done on PCs; the problem is simply that it's difficult to develop compact code that generates efficient layout. However, the IBM PC may eventually prove to be a good platform for layout as well.

You can perform the physical design of some semicustom ICs—namely ICs from Intercept, Custom Arrays, Gould AMI, and Matra Design Systems—on a PC-based design system. The Workview system offers fault simulation, and Daisy's Testmaster software performs testability analysis, fault simulation, and test-program development. Daisy also offers the expensive but highly accurate Logic Master IC-verification system from Integrated Measurement Systems (Beaverton, OR) as a peripheral to its Personal Logician; with this IC-verification system, Personal Logician costs $71,000. **EDN**

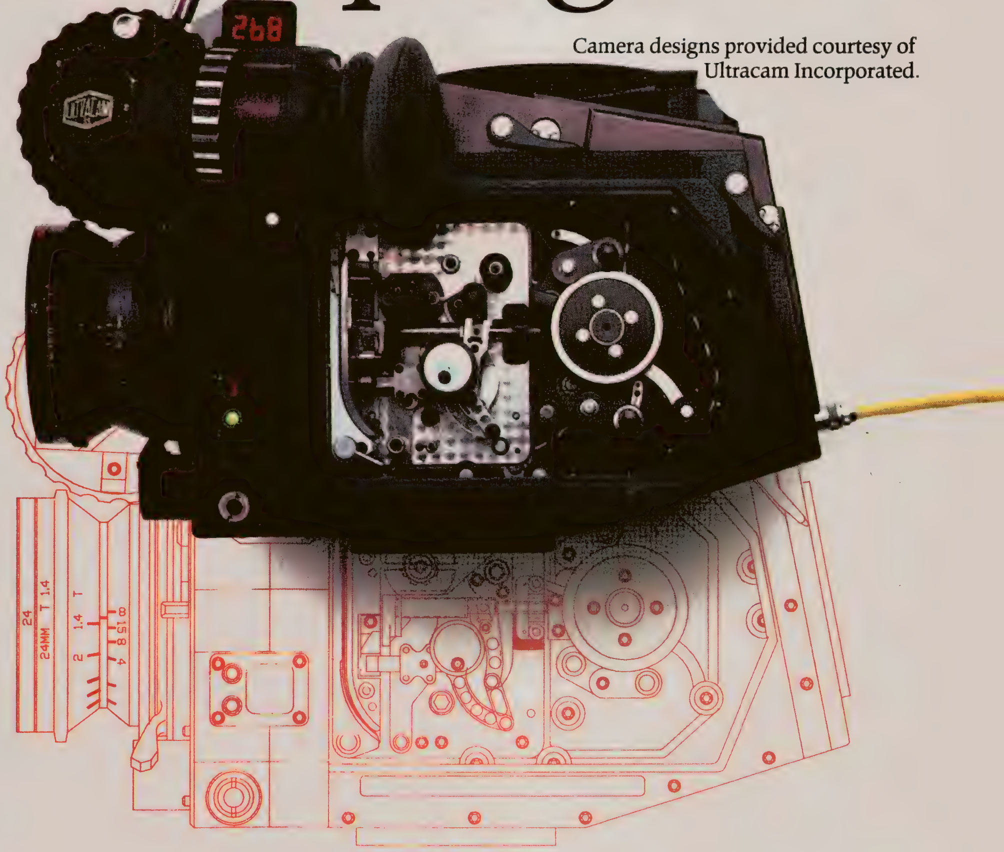
References

1. Emami, Shahriar, and Steve Brunner, "Logic Simulation on PCs," *VLSI Systems Design*, January, 1986, pg 36.

2. Gyurcsik, R S, et al, "Circuit and Logic Simulation on the IBM Personal Computer," EECS Department and Electronics Research Laboratory, University of California, Berkeley, CA.

Article Interest Quotient
(Circle One)
High 500 Medium 501 Low 502

Picture this on a $2,500 CAD program.



Camera designs provided courtesy of Ultracam Incorporated.

When Ultracam Incorporated set out to design the Ultracam™ K35, they knew that their design tool needed to be as professional as the camera they were designing. That's why they chose AutoCAD,™ the most widely used computer-aided design and drafting tool in the world today.

Mainframe CAD Capability at 5% of the Price

If you have an IBM PC, PC/XT, PC/AT, NEC, DEC, TI, Tandy, Wang, or one of over 30 desktop computers AutoCAD supports, you already own the most expensive part of a CAD system. Add AutoCAD for only $2500 more, and you can have the power of CAD on your desktop at a price you can afford. With a pointing device and a plotter (the choice is yours, we support over 50 popular peripherals,) you can assemble a complete CAD workstation for less than $10,000.

Once you've installed AutoCAD on your computer, you'll have a tool at your fingertips which removes the drudgery from designing.

Quick to Learn, Easy to Use

The beauty of AutoCAD is that you need no prior knowledge of computers. Even if you've never seen a CAD system, you'll pick it up in a matter of days, and feel comfortable within a week.

Simple pop-up menus point you in the right direction. You can also easily create your own menus. On-line HELP keeps you on track.

Sailboats, Landscapes, and Custom Homes

Since AutoCAD is general-purpose and user-customizable, it doesn't matter what type of drafting your work requires. Tens of thousands of AutoCAD users are creating drawings and developing designs in every discipline with ease and accuracy never experienced before.

The Heart of Your CAE System

Drawings are only part of the story. Pre-defined standard symbols, translators to allow AutoCAD to exchange drawings with mainframe CAD systems, data base analysis programs for bill of material lists, job costing and drawing distribution by telephone are only some of the capabilities available with AutoCAD. These capabilities make AutoCAD the central component in your desktop computer-aided engineering (CAE) system.

Whether you're in a two-person shop or a two-billion dollar company, you'll find that AutoCAD pays for itself in just a few months.

In the future, AutoCAD will run on newer, more powerful computers as they become available—so that you can be sure your investment in creating drawings and training staff won't be wasted.

Powerful New Capabilities

Call or write us today for the name of the dealer nearest you and a demonstration of the latest in AutoCAD capabilities, including polylines, curves, and 3D visualization with hidden line removal. Also ask about other cost-effective Autodesk products: AE/CADD™ and CAD/camera.™

AutoCAD, world leader in design and drafting software, will save you time and money.

AUTOCAD™
AUTODESK, INC.
2320 MARINSHIP WAY
SAUSALITO, CA 94965
(415) 331-0356
or (800) 443-0100 EXT. 406
TELEX 275946 ACAD UD
CIRCLE NO 39

Ultracam K35 is a trademark of Ultracam Incorporated. AutoCAD, CAD/camera and AE/CADD are trademarks of Autodesk Inc.

FUTURENET OVERCOMES THE 3 MAJOR OBSTACLES TO CAE

HIGH COST

LACK OF STANDARDS

OBSOLESCENCE

WITH MAINFRAME PERFORMANCE TOOLS FOR YOUR IBM PC.

MAINFRAME CAPABILITY FOR A FRACTION OF THE COST. The FutureNet® family of PC-based CAE tools gives you the high performance you demand, at a price you can afford. From the DASH™ Schematic Designer, DASH™-CADAT PLUS to the DASH™-PCB, our products let you take even the most complex designs through schematic capture, simulation, and printed circuit board layout—faster and easier than you ever thought possible.

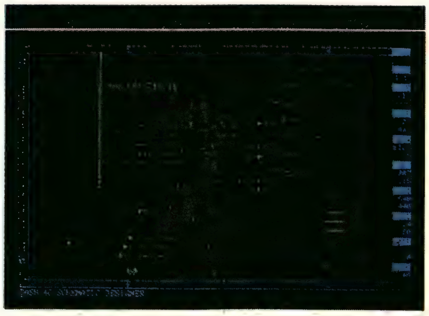
And our Personal Silicon Foundry™ gives you rapid design, testing and programming capabilities for programmable logic devices.

FUTURENET TALKS TO THE WORLD OF CAE/CAD. An open architecture and IBM® PC platform let you easily integrate our CAE system into your engineering environment. FutureNet offers many post processors to translate schematics into files compatible with your in-house CAD system. Complete database description and source software for net lists and drawing translators are also available.

And because DASH is an accepted CAE standard, it gives you immediate access to more than two dozen gate array foundries, as well as a wide variety of engineering service bureaus.

FUTURENET PROTECTS YOUR CAE INVESTMENT. We are committed to continually enhancing our CAE product line. Each new software version is compatible with the last, so you can always use your existing drawing files.

And you'll never have to worry about outgrowing your system. Our 32-bit co-processor gives you the power to add high performance logic simulation and PCB layout capability within the same platform. This flexible hardware design will also let you easily take advantage of tomorrow's new and more powerful processing capabilities.

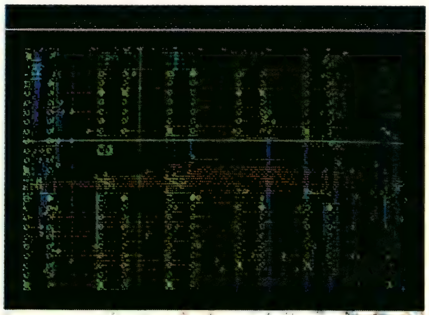


DASH SCHEMATIC DESIGNER: CREATE SCHEMATICS AT LIGHTNING SPEED.

- Most widely used schematic designer
- Symbol rotation/reflection, orthogonal rubber banding, snap-to-pin and more
- Simplified text annotation
- Extensive libraries of TTL, ECL, CMOS, and VLSI parts
- Help menus and on-line documentation
- Hierarchical structure for top-down and bottom-up design

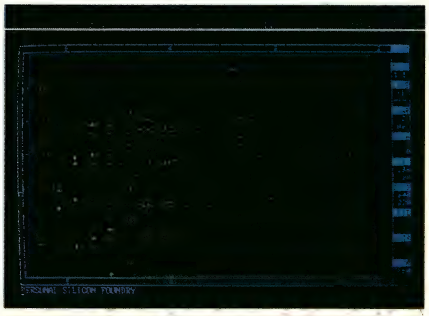
DASH-CADAT PLUS: SIMULATE LOGIC, TIMING AND FAULTS WITH THE POWER OF A MAINFRAME.

- Logic simulation up to 30,000 gates
- Fault simulation for full testability
- Rivals mainframe performance
- Display processor operates like a logic analyzer
- Stimulus language simplifies test vector generation
- Simulates at transistor, gate, functional or behavioral level
- ASIC libraries and optional hardware modeler



DASH-PCB: LAY OUT PCBs FOUR TIMES FASTER THAN THE EXPERTS.

- Expert multi-strategy router
- Trace hugging frees maximum number of routing channels
- Real-time rubber banding optimizes component placement
- Automatic 45 degree routing
- Board capacity up to 32″ X 32″
- Design rule checking ensures accuracy
- Multiple trace layers to handle the most complex designs



PERSONAL SILICON FOUNDRY: CONCEPT TO SILICON IN THREE HOURS.

- Integrated programmable logic design, optimization, verification, fault grading and automatic test vector generation
- Includes ABEL™, the industry standard high-level design language
- Converts DASH schematics into optimized PLD designs

BREAK THROUGH THE BARRIERS TO CAE. Call FutureNet today at **(818) 700-0691** and find out how our PC-based CAE system overcomes the obstacles to CAE. You'll get mainframe capability at a price you can afford.

Distributed by Hamilton Avnet.

Authorized IBM® Value-Added Dealer.

FutureNet Division 9310 Topanga Canyon Boulevard, Chatsworth, CA 91311-5728 (818) 700-0691/Telex 910-494-2681
DATA I/O Corporation 10525 Willows Road N.E., P.O. Box 97046, Redmond, WA 98073-9746, U.S.A. (206) 881-6444/Telex 15-2167
DATA I/O Europe World Trade Center, Strawinskylaan 633, 1077 XX Amsterdam, The Netherlands (20) 622866/Telex 16616 DATIO NL
DATA I/O Germany Bahnhofstrasse 3, D-6453 Seligenstadt, Federal Republic of Germany (6182) 3088/Telex 4184962 DATA D
DATA I/O Japan Ginza Orient Building, 6F, 8-19-13, Ginza Chuo-ku, Tokyo 104, Japan (03) 574-0211/Telex 2522685 DATAIO J

FutureNet
A Data I/O Company

CIRCLE NO 40

RISC

VERSATEC HAS YOUR NUMBER IN ELECTROSTATIC COLOR PLOTTING: 42, 36 AND 24.

The inventor of electrostatic color plotting has done it again. Versatec second-generation electrostatic color plotters deliver proven performance in new affordable 24 and 36-inch plotting widths. Now you can choose the width that best fits your color hard copy needs.

More affordable plots. You get the turnaround, throughput, and proven performance of Versatec's famous ECP-42 at a lower price. And your consumables cost is lower than that of thermal, inkjet, or photoplotter devices.

One Versatec color plotter can deliver more plots to a network or workstation cluster than ink jets or multiple pen plotters. Users get faster response at less cost. And reliable Versatec plotters run unattended. With no pens to skip, jets to plug, or film to change or develop.

Multi-pass wins! Proven Versatec multi-pass color plotters save money, space, and CPU overhead. They produce better color, faster monochrome plots. On paper or film.

Plotters plot, promises don't. Hundreds of Versatec electrostatic color plotters are at work in CAE/CAD, geophysical imaging, and other computer graphics applications. Versatec has been delivering color plotters since June, 1983.

The safe choice. Versatec is the only company with a full-time service organization devoted exclusively to electrostatic plotters. General computer peripheral maintenance or third-party service could leave you with inadequate support.

It's real. See what Versatec electrostatic color plotters can do for you. Circle the readers' service number or call our toll-free number 800/538-6477 (in California, 800/341-6060).

See Versatec at A/E/C SYSTEMS and SIGGRAPH

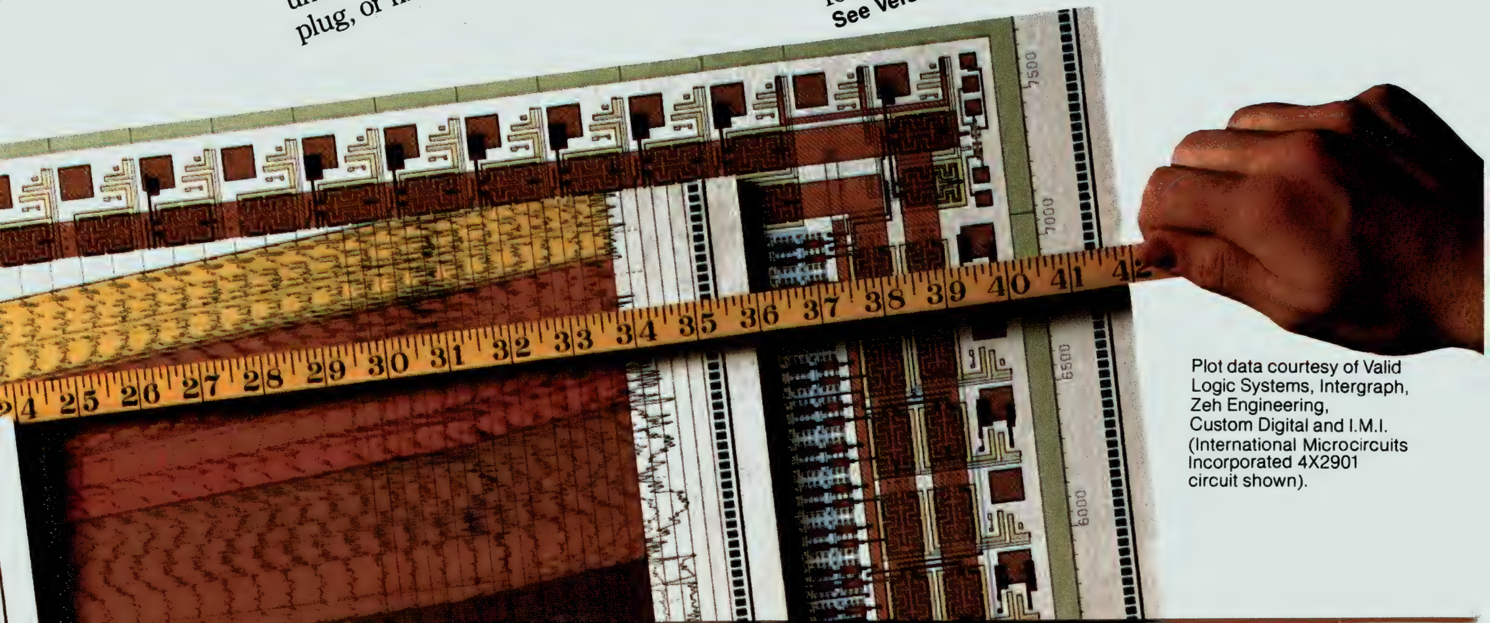
VERSATEC
A XEROX COMPANY

2710 Walsh Avenue
Santa Clara, California 95051
Telephone: (408) 988-2800
Call toll-free: (800) 538-6477
In California, call (800) 341-6060
TWX: 910-338-0243
Telex: 334421

Versatec is a trademark of Versatec, Inc. Xerox is a trademark of Xerox Corporation.

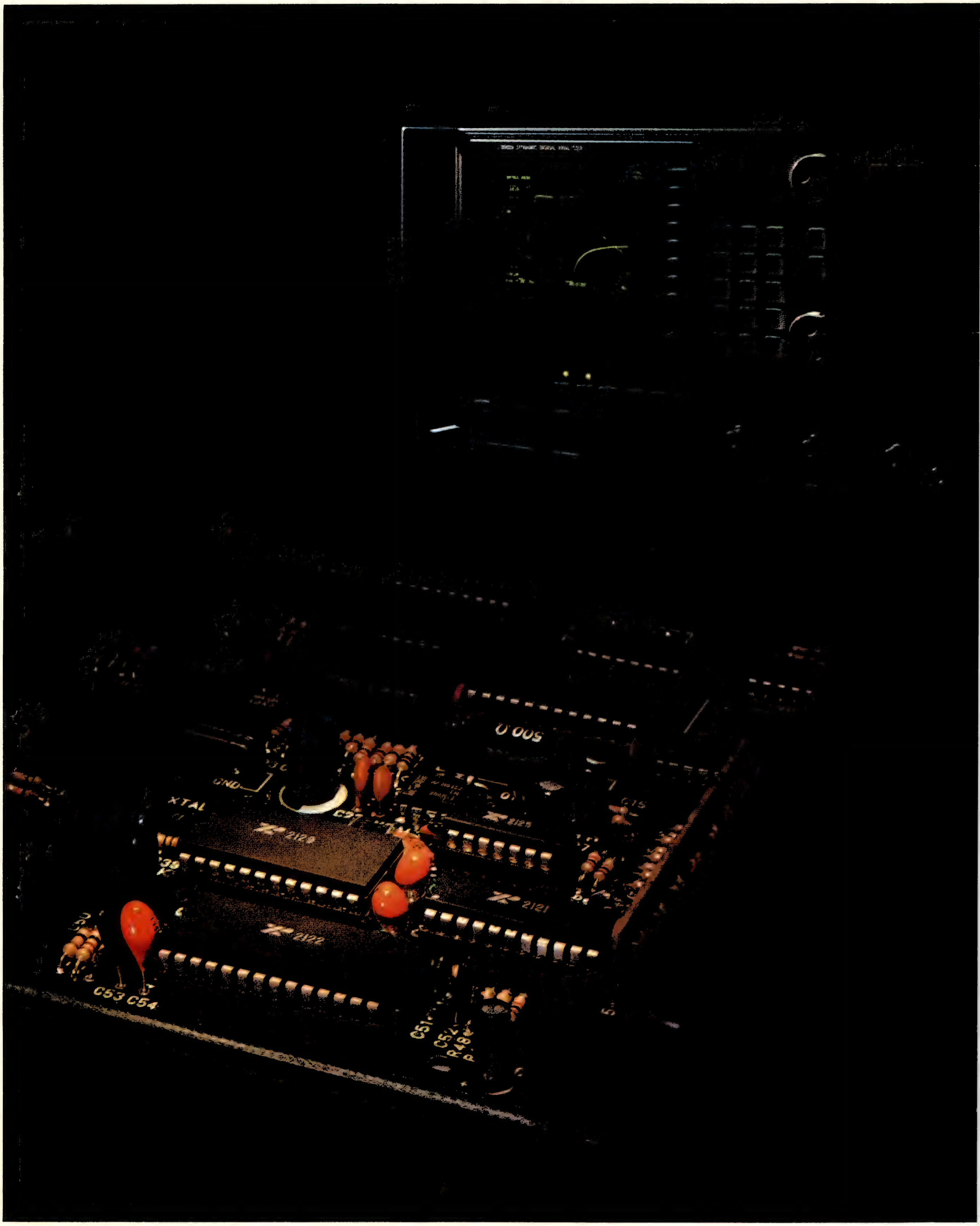
It's a Versatec.

CIRCLE NO 42



Plot data courtesy of Valid Logic Systems, Intergraph, Zeh Engineering, Custom Digital and I.M.I. (International Microcircuits Incorporated 4X2901 circuit shown).

EXAR sets new standards



in 212A/V.22 modem filters.

XR-2129 Improves Modem Features

Now you can enhance your system to perform better than the competition with the XR-2129, EXAR's newest version modem filter for 212A/V.22 applications.

Features Include:
- Analog Loop Back Capability.
- Call Progress Monitoring (both normal & enhanced modes).
- 1.8432 MHz on-chip oscillator – provides full modem clocking capability in conjunction with XR-2121, XR-2122 & XR-2125.
- Additional worst-case line (CO) equalizer.
- Available in Surface Mount Quad Pack.

Expertise in Filters

For years, EXAR has been providing switched capacitor filter products in several areas:
- Modems: Bell 212A/CCITT V.22 and the Bell 103.
- General Purpose: Fourth order low pass and programmable low/high/all pass filters.

In addition, EXAR has complete custom capabilities to give you an even greater competitive edge through user specific switched capacitor filter ICs.

The EXAR Family of Filters and Modems

Device	Application	Type	Speed (BPS)	Tech-nology	Features
(Filters) **XR-2120**	Bell 212A	PSK/ FSK	1200/300	CMOS	Low external component Small package (.4" wide, 22 pin)
XR-2126	Bell 212A/ CCITT V.22 CCITT V.22 bis	PSK/ FSK	1200/300/ 2400	CMOS	AMI S35212 compatible Reticon RM5632A compatible Call Progress monitoring
XR-2127	Bell 212A/ CCITT V.22 CCITT V.22 bis	PSK/ FSK	1200/300/ 2400	CMOS	AMI S35212A compatible ALB test mode Call Progress monitoring
XR-2128	Bell 212A/ CCITT V.22 CCITT V.22 bis	PSK/ FSK	1200/300/ 2400	CMOS	ALB test mode Enhanced Call Progress monitoring (fo/2.5)
XR-2129	Bell 212A/ CCITT V.22 CCITT V.22 bis	PSK/ FSK	1200/300/ 2400	CMOS	Designed to complement XR-2121/XR-2122/ XR-2125 1.8432 MHz onboard oscillator Additional worst case line equalizer ALB test mode
(Modems) **XR-2121**	Bell 212A	PSK/ FSK	1200/300	CMOS	Complete PSK and FSK modulation Digital echo modulation for 1200 BPS On-board scrambler
XR-2122	Bell 212A	PSK/ FSK	1200/300	CMOS	Complete PSK and FSK demodulation Coherent Costas Loop 1200 BPS demodulator On-board descrambler
XR-2125	Bell 212A		1200	CMOS	Low power 5 V operation No external parts Complete async to sync and sync to async conversion
XR-2123A	Bell 212A/ CCITT V.22 Bell 201/ CCITT V.26	PSK	1200/2400	CMOS	PSK modulation and demodulation Low power 5 V operation

XR-2126/27/28 Set Industry Standards

EXAR New Standard	AMI	Reticon	Improvements
XR-2126	S35212	RM5632A	Improved guard tone notches
XR-2127	S35212A		Additional CO line equalizing
XR-2128			Improved Call Progress Monitoring

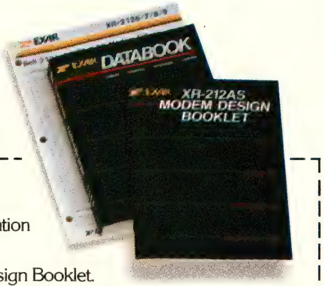
Price Competitive and Available Now

You can get improved performance and features for your applications immediately from EXAR at a competitive price.

With EXAR's systems approach, we can assist you in handing your customers a complete solution. Just give us a call or clip the coupon below and we'll give you the entire story.

EXAR is an innovator in User Specific ICs and offers one of the industry's largest lines of proprietary and alternate-sourced ICs in the application specific and general purpose standard products area used in telecommunications, digital data processing, and industrial control applications.

As well as wafer foundry services, EXAR offers the most comprehensive User Specific programs in the industry using bipolar, CMOS (metal & silicon gate) and I^2L technologies.



☐ Please send me additional information on the XR-2126/27/28/29.
☐ Please send me the XR-212AS Design Booklet.
☐ Please send me EXAR's full line databook.

EDN860626

Name__________ Title__________
Company__________ Dept./Div.__________
Address__________
City__________ State______ Zip______
Phone (_____)__________ Ext.______
Application__________

EXAR

750 Palomar Avenue, Sunnyvale, CA 94086 Tel. (408) 732-7970 TWX 910-339-9233.

CIRCLE NO 44

MS-DOS 3.1 ON THE STD BUS: INDUSTRIAL QUALITY AND COMMERCIAL CONVENIENCE FROM PRO-LOG.

Your control system has a lot riding on it. A million-dollar production facility. Life-giving medical equipment. Tomorrow's daily newspaper. It needs to work. . . and keep on working.

Whatever your application, you can benefit from Pro-Log's STD-DOS: The convenience and familiarity of IBM PC/AT® software and operating standards, but in rugged, industrial-quality hardware. It works . . . and keeps on working.

INDUSTRIAL QUALITY:

Operates 0° to 65°C for more than 10 years with an average MTBF of more than 20 years per card. Backed by Pro-Log's 5-year parts and labor warranty.

COMMERCIAL CONVENIENCE:

Microsoft's® MS-DOS 3.1 is a software bus for connecting libraries, languages, editors, and application programs.

The STD BUS is an industry standard hardware bus for connecting memory, I/O, and peripheral functions.

The IBM PC/AT or clone is your development tool.

STD-DOS FEATURES: WITH 2 CARDS

- 8088 CPU, 5 MHz
- Time-of-day clock
- MS-DOS 3.1 in ROM disk
- 128K-byte user ROM disk
- 16K-byte user RAM disk
- 112K bytes system RAM
- RS-232-C, RS-422/485 ports
- I/O expandable to 24 STD BUS card slots
- Memory expandable to 640K bytes
- Under $1200

NEW SOFTWARE! . . . STD-LIB 1.1: a fully documented disc-resident library of driver software that supports Analog and Digital STD BUS cards for "C", BASIC, and Assembly language programs.

For information on STD-DOS products, local seminars, or a personal demonstration, CALL or WRITE TODAY. **Circle 13 for literature only**

PRO-LOG® CORPORATION

2560 Garden Road, Monterey, CA 93940 (408) 372-4593, Outside CA: (800) 538-9570, TLX: 171879; Australia (3) 836-3533; Canada (416) 625-7752; England (0276) 26517; France (1) 3956-8142; Germany (07131) 50030; Italy (2) 498-8031; Switzerland (01) 62 44 44.

®Microsoft and MS-DOS are registered trademarks of Microsoft Corporation
®IBM is a registered trademark of International Business Machines Corporation
©1986 ADGROUP International PL052

Circle 52 for direct factory contact

Programmable switched-capacitor filter ICs cut component count in many filter types

Denny Cormier,
Regional Editor

Today's universal switched-capacitor filter ICs let you program the design of any classical type of high-order active filter—lowpass, highpass, bandpass, or bandstop (notch)—with only a few external resistors and no external capacitors. In addition, the devices allow use of a crystal-controlled oscillator with which you can tune your filter's frequency specs. Moreover, some of the parts even let you vary parameters by means of a µP. To simplify your filter-design task further, several special-purpose switched-capacitor filter ICs are available for specific kinds of filters—for example, Butterworth, Chebyshev, and elliptic types.

The switched-capacitor integrators in the ICs are already frequency compensated, freeing you from the task of making such adjustments. In contrast, traditional active filters require closely matched capacitors that have low temperature drift. Also, filters made with switched-capacitor ICs need far fewer components than do filters made the traditional way—with multiple op amps. The resulting reduction in components and fabrication time can mean considerable savings in development and production costs.

Universal switched-capacitor filters are based on the state-variable system technology originally developed for use in analog computers. Active-filter circuits based on the state-variable technique employ cascaded op-amp integrators. Chip makers have combined the cascaded-integrator approach with switched-capacitor technology to create universal state-variable active-filter ICs that can furnish highpass, bandpass, and lowpass outputs (see **Ref 1**).

By using simple resistor networks, you can configure the state-variable outputs of a universal switched-capacitor filter IC into a wide array of filter types **(Fig 1)**.

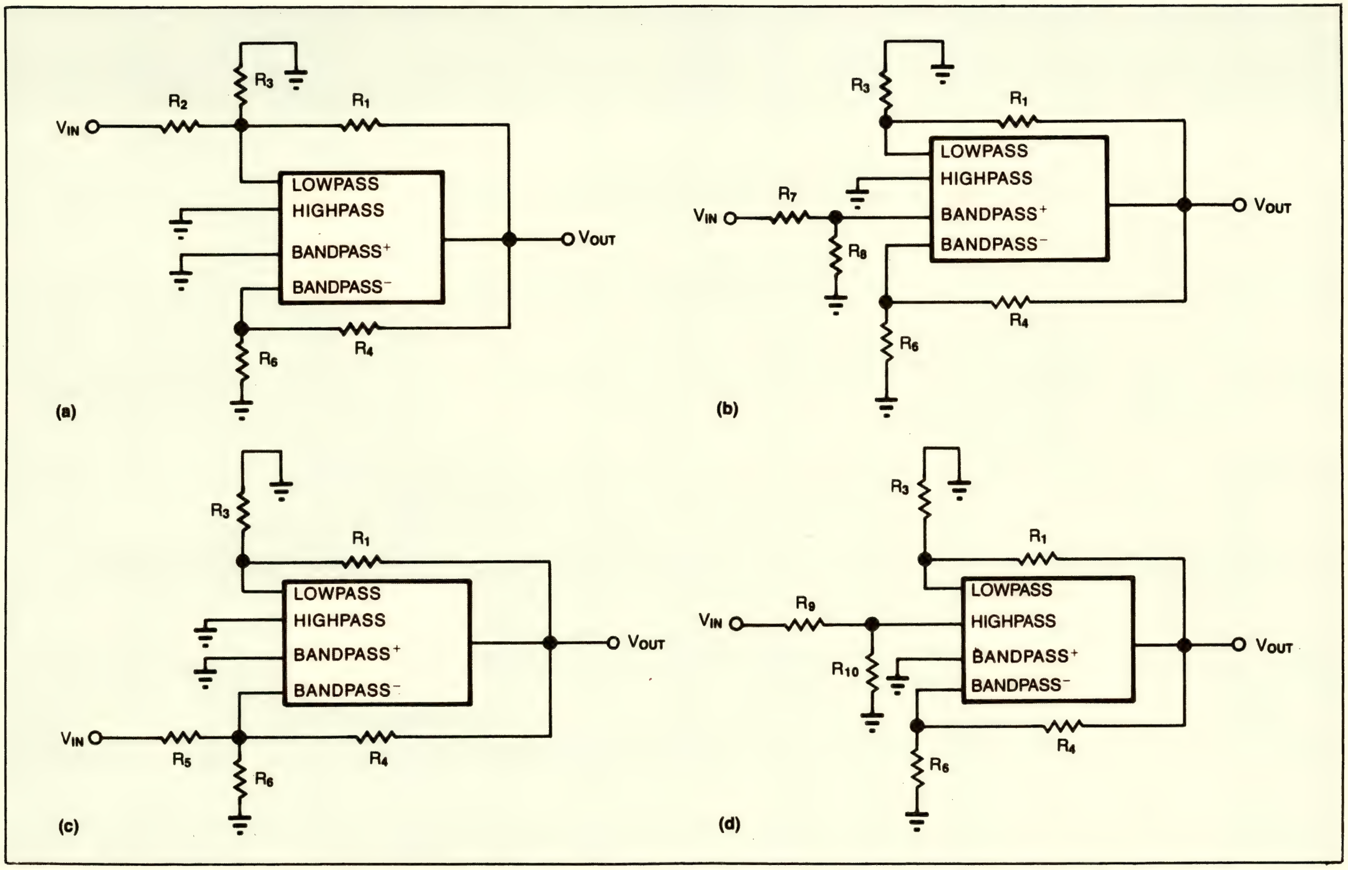


***Fig 1—State-variable switched-capacitor filter ICs** make it easy for you to build standard lowpass **(a)**, noninverting bandpass **(b)**, inverting bandpass **(c)**, and highpass **(d)** filters by merely changing the configurations of the external programming resistors.*

Copies of articles from this publication are now available from the UMI Article Clearinghouse.

For more information about the Clearinghouse, please fill out and mail back the coupon below.

Yes! I would like to know more about UMI Article Clearinghouse. I am interested in electronic ordering through the following system(s):

☐ DIALOG/Dialorder
☐ OnTyme
☐ ITT Dialcom
☐ OCLC ILL Subsystem
☐ Other (please specify)____________________
☐ I am interested in sending my order by mail.
☐ Please send me your current catalog and user instructions for the system(s) I checked above.

Name____________________
Title____________________
Institution/Company____________________
Department____________________
Address____________________
City__________State______Zip__________
Phone (   )____________________

UMI Article Clearinghouse

Mail to:

University Microfilms International
300 North Zeeb Road, Box 91
Ann Arbor, MI 48106

(Consult **Refs 2** and 3 for the formulae to compute the resistor values that control frequency-response parameters.) In addition, the ability to tune switched-capacitor ICs by means of a crystal-controlled oscillator enables you to lock the center frequency of a bandpass filter to a specific frequency or to adjust the center frequency electronically with little or no temperature drift.

Variations on a theme

The first state-variable switched-capacitor filter IC, National Semiconductor's MF10, appeared in 1980. The device, fabricated with a conventional metal-gate CMOS process, has since become an industry standard. You can create fourth-order filter functions (24-dB/octave rolloffs) by cascading the MF10's dual sections. Bandwidths are as high as 30 kHz, and the filter can furnish ±4V output swings when powered by a ±5V supply. Both sections of the device typically draw about 8 mA of supply current. When supplied in a 20-pin DIP, the part is designated the MF10CCM and costs $2.30 (100). Maxim Integrated Products offers a pin-compatible version of the MF10, called the MF10CN, at a cost of $2.33 (100) in a 20-pin plastic DIP.

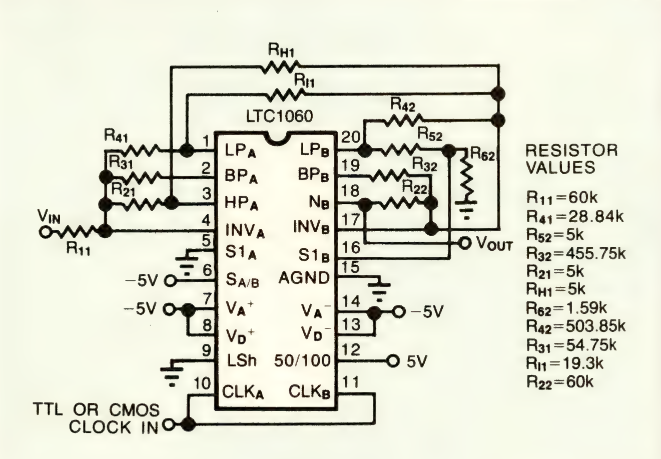
Linear Technology employs a polysilicon-gate CMOS process to make a pin-compatible version of the MF10, the LTC1060. The part offers approximately 30% more bandwidth (40 kHz) and tolerates roughly 30% higher supply voltages than National's part, and it draws about the same amount of supply current. The industrial-version LTC1060ACN comes in a 20-pin DIP and costs $8 (100). Harris Corp's HF-10 is another polysilicon-gate version of the MF10. The HF-10 operates over the military temperature range (−55 to +125°C) with a maximum bandwidth of 50 kHz. It costs $7.99 (100).

For applications like antialiasing, which require only second-order filters, or for designs requiring additional attenuation of harmonics, National makes a single-stage version of its MF10, the MF5. Supplied in a 14-pin DIP, the part costs $1.45 (100). Linear Technology supplies a pin-compatible, polysilicon-gate version of the MF5, the LTC1059, which sells for $4.30 (100).

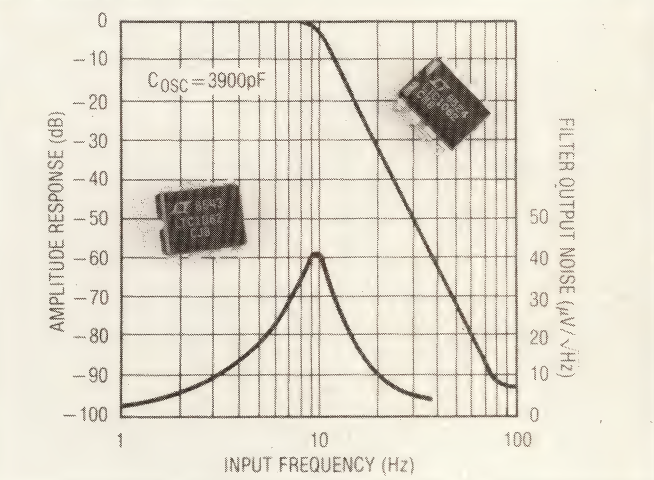
Despite their higher fabrication costs, polysilicon-gate switched-capacitor filter ICs should eventually replace metal-gate parts. Linear Technology's senior staff engineer, Nello Sevastopoulos, who directed the original MF10 design team at National, says that the polysilicon-gate fabrication process accounts for most of the improved performance specs of the LTC1060. Parts like LTC1060 work at higher power-supply voltages (18V rail to rail), and they spec lower noise floors—in the submillivolt range, thus allowing you to operate the IC from supply voltages as low as ±2.5V—and more output swing than metal-gate devices. Consequently, polysilicon-gate parts achieve greater effective dynamic range than do the MF10 and similar parts.

In addition to improvements in dynamic range, polysilicon-gate switched-capacitor filter ICs spec increased bandwidths and greater frequency stability compared with their metal-gate counterparts. For instance, in any classical active-filter configuration, the LTC1060 can maintain frequency stabilities of 0.3% over the entire military temperature range. The military version of National's MF10 specs only 3% frequency stability. Furthermore, polysilicon-gate transistor cells tend to exhibit longer lifetimes and about 10-dB less internal noise than metal-gate transistor cells.

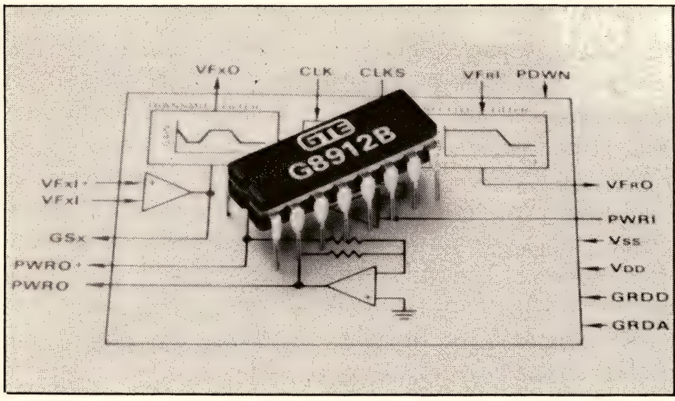
In fact, National plans to introduce its own polysilicon-gate version of the MF10, the LMF100, late this summer. The part will be fabricated with a proprietary analog polysilicon-gate CMOS process, and it



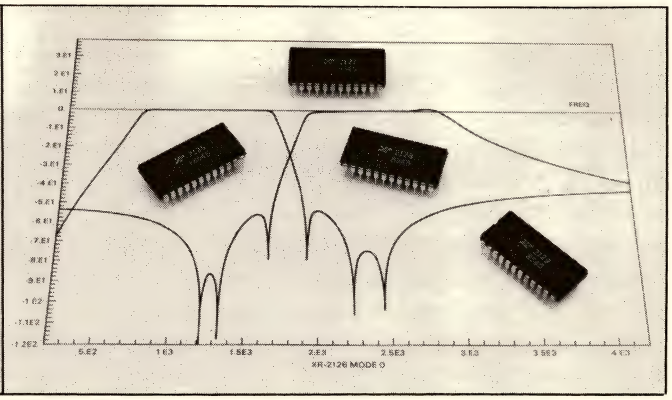
Although the resistor values have to be very precise, *you can implement this clock-tuned, fourth-order elliptic notch filter using both sections of Linear Technology's LTC1060 universal switched-capacitor filter IC.*



A polysilicon-gate CMOS circuit *within Linear Technology's LTC1062 dedicated Butterworth lowpass filter completely eliminates dc offsets while providing exceptionally low noise figures within the passband.*



Compatible with Bell D3/D4 and CCITT G.712 standards, *the G8912B switched-capacitor PCM transmit/receive filter chip from GTE Microcircuits provides (sin x)/x correction and 50/60-Hz harmonic rejection for D/A signal conditioning into phone trunk lines.*



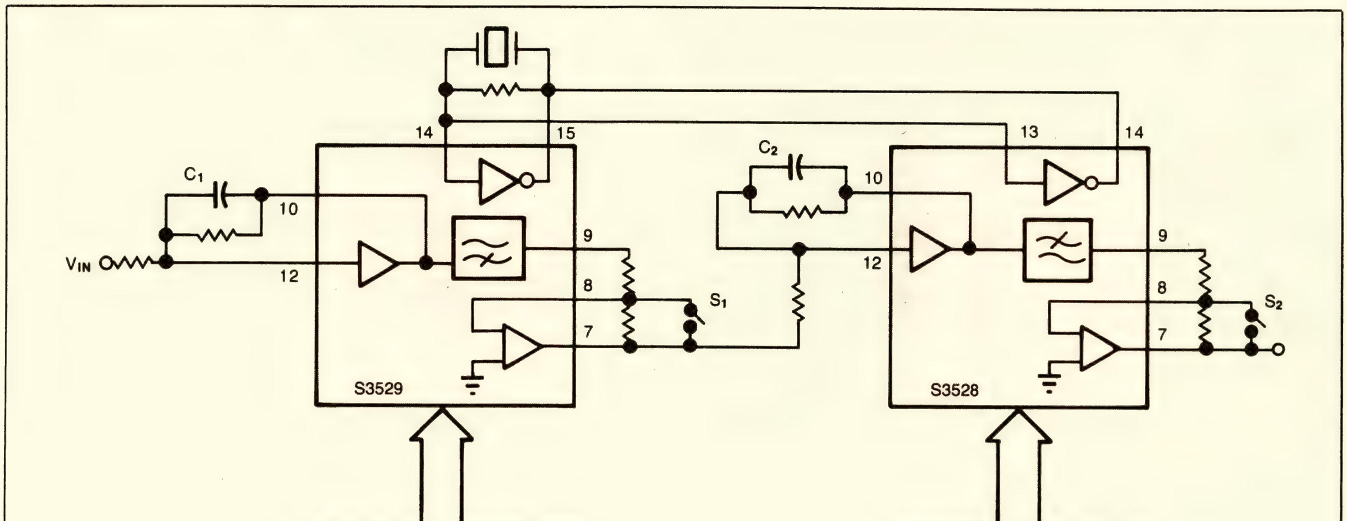
The XR-2126/27/28/29 Series of switched-capacitor modem-filter ICs *from Exar not only handles Bell-212A and CCITT-V.22 filter standards, but also provides delay equalization, transmit squelch, and originate/answer mode selection.*

will come in a package that's pin compatible with the MF10. The cost will be slightly higher. The LMF100 should be able to handle supply voltages as high as ±20V.

Fewer outputs for small package

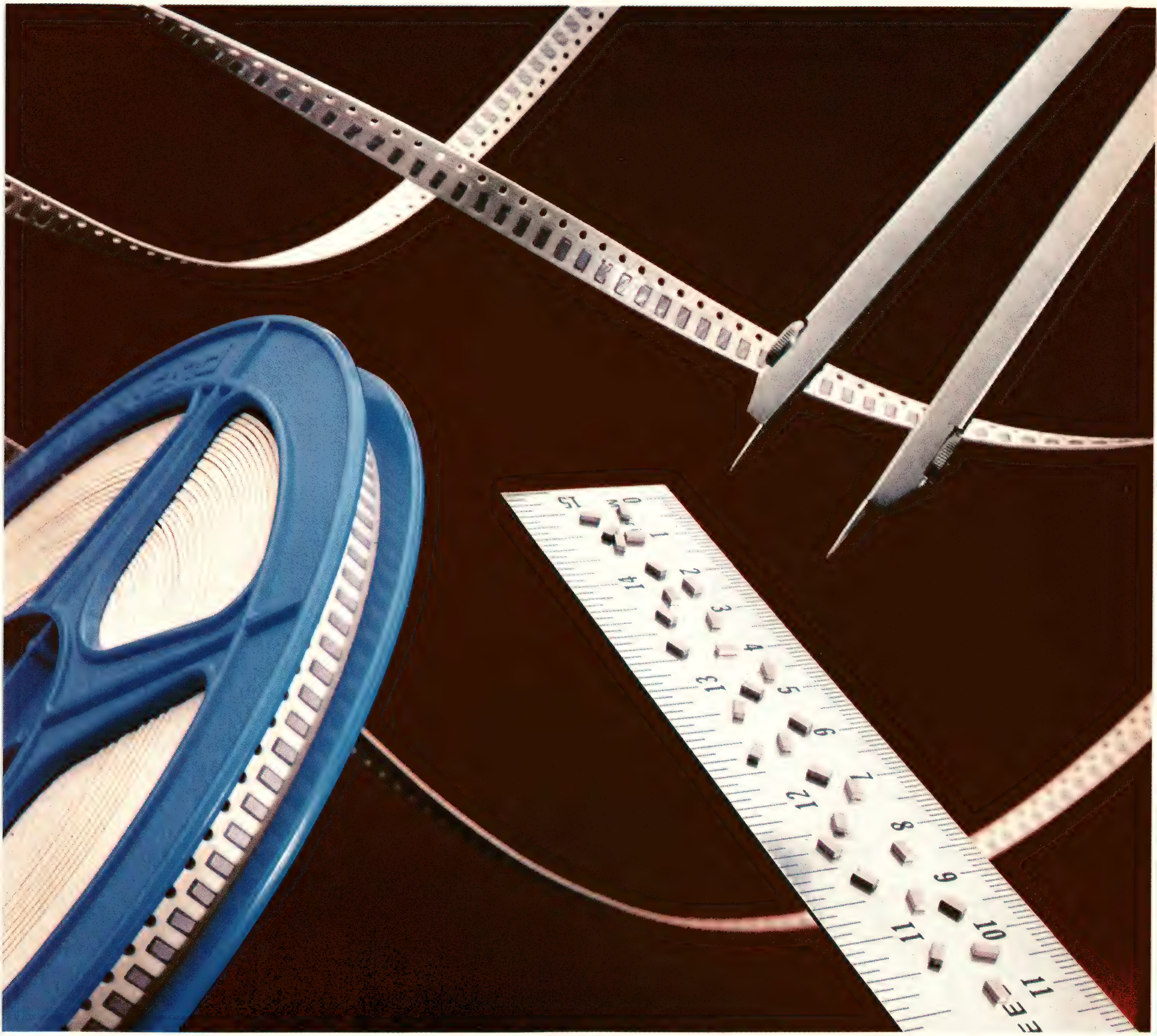
EG&G Reticon is another company that makes universal switched-capacitor active filters from polysilicon-gate NMOS IC technology. The parts handle supply voltages as high as ±10V. The company's dual (two poles each) RU5621A is functionally compatible, but not pin compatible, with the MF10. Although it's resistor programmable like the MF10, the RU5621A's integrator sections have fewer output pins than National's part, and the RU5621A therefore requires only a 14-pin DIP. It costs $3 (100). For the design of higher-order active filters, EG&G Reticon offers an 8-pole (quad 2-pole), resistor-programmable filter IC, the RU5622A, which comes in a 20-pin DIP and costs $4.80 (100).

In addition to its resistor-programmable parts, EG&G Reticon supplies a second-order universal active-filter IC, the RU5620A, which lets you logarithmically alter the filter's Q factor and the clock/center-frequency ratio by means of two 5-bit input codes. The 5-bit codes let you independently select a Q that ranges from 0.57 to 85 and a frequency range that varies from one-half to two times the clock frequency. By manipulating the control bits, you can shift center frequencies around in real time for adaptive filtering, or you can change the cutoff points of highpass and lowpass filters for audio descramblers or Dolby filters. Supplied in an 18-pin DIP, the RU5620A sells for $4.25 (100). Although it's more specialized than the RU5620A, National's MF8 fourth-order switched-capacitor bandpass filter also allows digital control of the Q factor, from 0.5 through 90, with a



Instead of using programming resistors, *you can configure a µP to control cutoff frequencies in Gould/AMI's dedicated S3528 lowpass and S3529 highpass seventh-order elliptic-filter ICs. By cascading an S3528 and an S3529, you can create this software-tuned elliptic bandpass filter.*

PICK-AND-PLACEABLE.



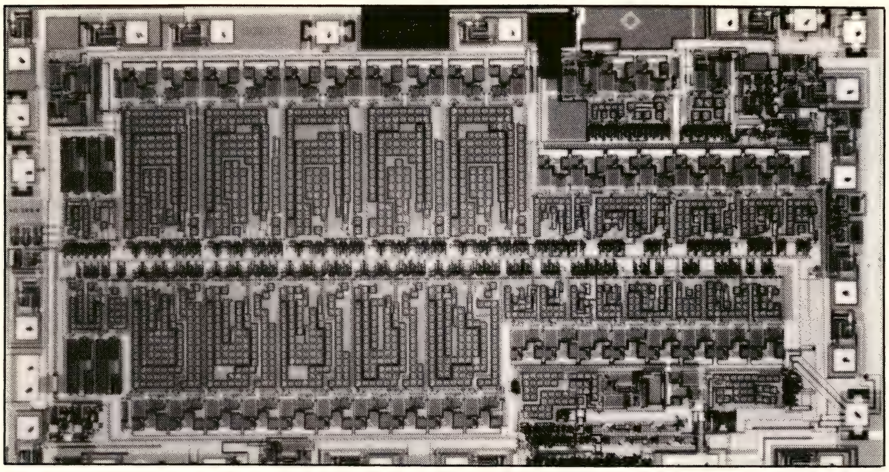
4SZ-3158R2

SPRAGUE CHIP CAPACITORS FIT EXACTING NEEDS.

Sprague Type 11C Monolythic® Ceramic Chip Capacitors are cost competitive and available today on 8mm reels for easy automatic placement and attachment to printed wiring boards and hybrid circuits. These multilayer chip capacitors are supplied with a choice of metallized terminations to fit the needs of both surface-mounting and hybrid technologies. They are furnished in a full range of capacitance and temperature characteristics. *Sprague Electric Company, a Penn Central unit,* Worldwide Hdqtrs., Lexington, MA. Write for Engineering Bulletin 6200F to Technical Literature Service, Sprague Electric Company, 41 Hampden Road, Mansfield, MA 02048-1807.

SPRAGUE
THE MARK OF RELIABILITY

CIRCLE NO 46



***Bell-212A and CCITT-V.22 modem filtering** is made simpler with Sierra Semiconductor's SC11001 switched-capacitor IC. The device includes an on-chip compromise equalizer, a multiplexer for analog loop-back testing, and a call-progress monitor signal.*

5-bit register. The MF8CCN comes in an 18-pin DIP for $2.17 (100).

Another digitally programmable switched-capacitor filter IC, the MX406, is manufactured by Mx-Com Inc, a subsidiary of Consumer Microcircuits Ltd (Witham, UK). This second-order filter chip has a 3-bit register to allow eight digitally programmable Q values between 0.54 and 8. The $4.19 (1000) MX406P is available in a 22-pin DIP.

Many switched-capacitor filter ICs are better suited to one classical filter type or another. Butterworth filters are a common application, because their spectral parameters are easily controlled by switched-capacitor filter ICs. Furthermore, Butterworth filters feature a linear phase response and minimal distortion characteristics because of their low-Q sections.

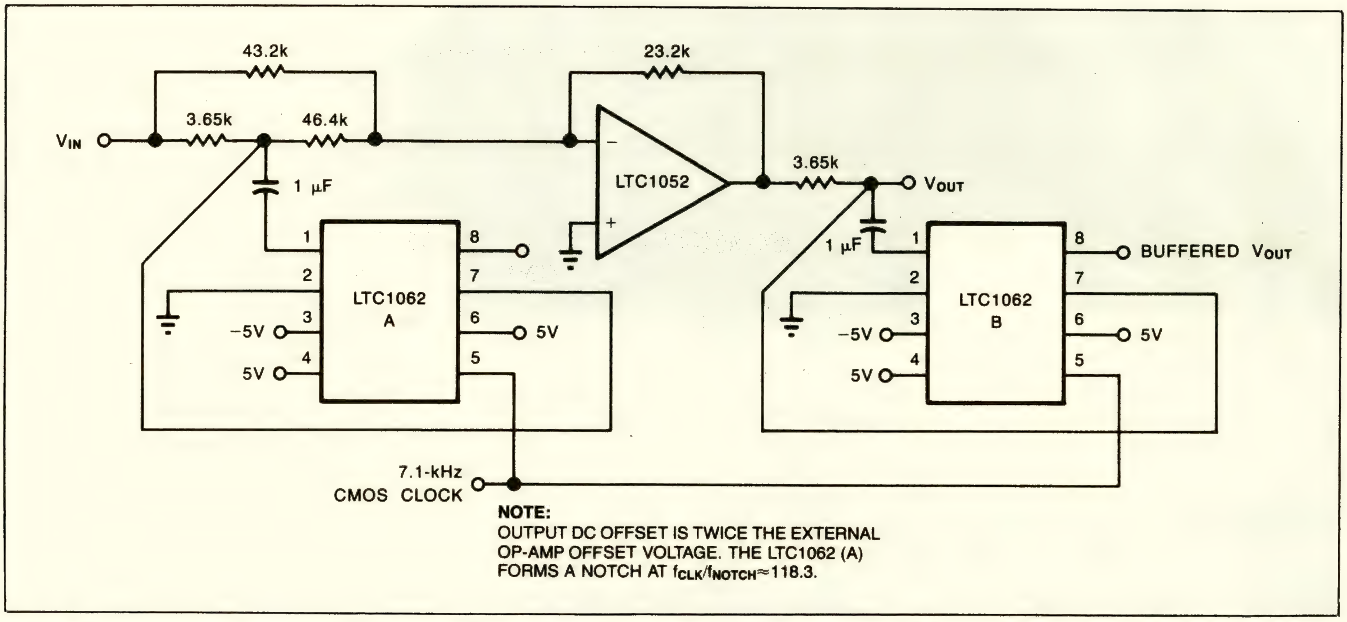
Consequently, the filters are well-suited to such lowpass-filter applications as antialias filtering, speech synthesis, and baseband demodulation. Although low efficiencies limit rolloff to no more than approximately 30 dB/octave, Butterworth lowpass filters remain popular because you can easily control their performance in the passband and reject harmonics in their stopband.

Dedicated to Butterworth

Linear Technology and National Semiconductor have created dedicated Butterworth lowpass-filter ICs using switched-capacitor technology. Linear's LTC1062 fifth-order lowpass-filter IC specs a 20-kHz max bandwidth. In addition to providing an on-chip antialiasing filter, the LTC1062 eliminates dc offset voltages in shunt-mode operation by using capacitive coupling—ie, the filter IC is outside the signal's dc path.

By combining two LTC1062s, you can make a lowpass filter that contains a high-attenuation 60-Hz notch filter **(Fig 2)** for use in applications where line-current devices are close to high-impedance transducer devices. LTC1062s each come in an 8-pin plastic miniature DIP; prices of the industrial version, the LTC1062C, start at $3.55 (100).

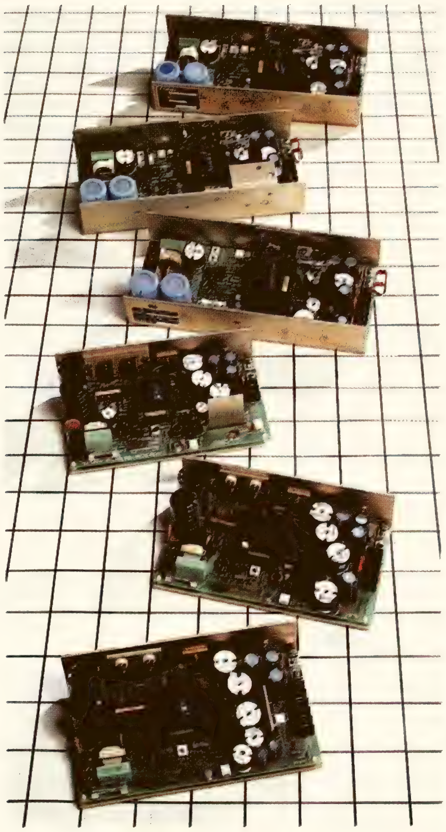
A functionally similar part that also specs a 20-kHz max bandwidth



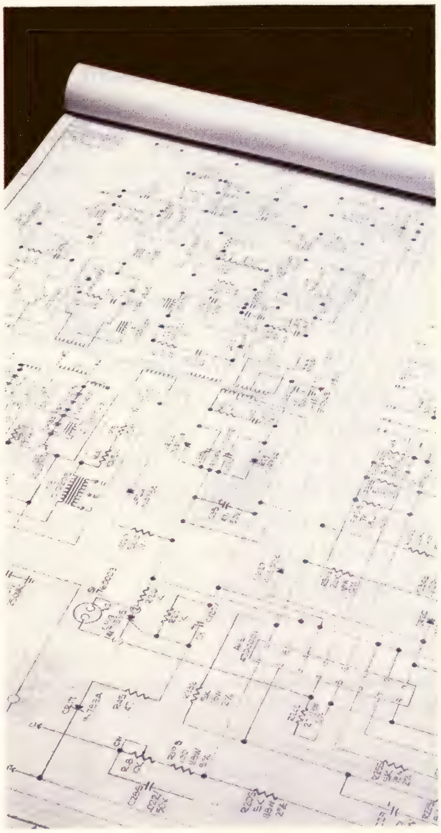
NOTE:
OUTPUT DC OFFSET IS TWICE THE EXTERNAL OP-AMP OFFSET VOLTAGE. THE LTC1062 (A) FORMS A NOTCH AT $f_{CLK}/f_{NOTCH} \approx 118.3$.

***Fig 2—You can easily construct a low-noise, zero-offset Butterworth filter** with two of Linear Technology's LTC1062 fifth-order, switched-capacitor lowpass-filter ICs. The filter has a 60-Hz notch that renders the circuit useful for rejecting EMI pickup from single-ended transducers.*

Introducing
TODD's High Tech Switcher Lines



Catalog Line



Engineered Line

800 Line

Call 1-800-223-TODD. It's your *direct* line to Todd's advanced technology. You'll talk with an engineer who knows OEM design problems and power supply solutions.

From the Todd Catalog. A full line of switchers 31% smaller than industry average. Field-proven reliability. Fewer components. Higher efficiency. Lower noise. Cooler running. Tomorrow's designs—off-the-shelf today.

From the Todd Technology Bank. Modified or customized by Todd engineers for your design when a catalog switcher isn't quite right. Todd's technology continues to lead the industry. With application proven designs. With innovations like VERI-DRIVE PLUS to prevent transformer core saturation effects and DYNAFLUX to minimize output filter section size. With automated manufacturing innovations like SMT and chip-on-board construction.

TODD
Switching Power Supplies

For the solution to your power supply problem, call 1-800-223-TODD. Your direct line to Todd specialists with the know-how to work with you, and the switchers that fit.

Call 1-800-223-TODD
(Or Call 516-231-3366)

Yes, I need a power supply solution. Send me a Todd Catalog. I'll take it from there.

Name ____________________
Title ____________________
Company ____________________
Address ____________________
____
Phone ____________________

Send to: Todd Products Corp., Dept. D-26
50 Emjay Blvd., Brentwood, N.Y. 11717

EDN62686

CIRCLE NO 48

is the MF6-50 sixth-order lowpass filter from National. The device contains an optional internal clock and specs cutoff-frequency accuracies of ±0.3%. Although the part does not have the dc-offset cutout of the LTC1062, unity dc gain still allows you to cascade the MF6-50 for sharp cutoffs and high attenuation of stopband harmonics. National supplies the MF6CN-50 in a 14-pin DIP for $1.90 (100).

Parts for elliptic filters

Even elliptic lowpass filters with restricted dynamic range can benefit from the reduced parts count that switched-capacitor filter ICs can confer. For example, EG&G Reticon supplies the RF5609A, a 7-pole, 6-zero elliptic lowpass filter that employs switched-capacitor technology. The part specs an out-of-band harmonic rejection of greater than 75 dB for such applications as antialias and tracking filters. Supplied in an 8-pin DIP, the device sells for $5.75 (100).

Gould/AMI's functionally similar S3528 is a switched-capacitor elliptic (seventh-order) lowpass-filter IC. A 6-bit register accepts μP inputs for programming the filter's cutoff frequencies, which range from 44 to 22,372 Hz. Using a few additional external resistors, you can configure the part as a digitally tuned audio oscillator for spectrum analyzers or alarm systems.

To complement the S3528, the company offers the S3529 seventh-order elliptic highpass filter, which furnishes the same digital programming features and switched-capacitor technology as the S3528. By combining the two parts, you can easily make a digitally tuned bandpass or notch filter that suits such applications as computer-controlled analog testers and telemetry filters. Both devices come in 18-pin DIPs and cost $3.90 (1000).

Compromise with Chebyshev

Chebyshev filters are a compromise between Butterworth and elliptic filter circuits. If your application requires less than 85-dB attenuation in the stopband relative to the passband and rolloffs between 30 and 60 dB/octave, a Chebyshev filter design can offer many of the desirable features of an elliptic filter without the tricky balance problems.

For those who would like to convert the spectral response of a system to the ANSI Chebyshev (6-pole) bandpass-filter standards, EG&G Reticon offers its RF5614/5/6A (ANSI Class II) and RM5604/5/6A (ANSI Class III) switched-capacitor chip series. The members of the two series handle ⅓-, ½-, and full-octave frequency responses, respectively. These Chebyshev filters are already becoming popular with engineers who build speech-synthesis and voice-recognition circuitry. The RF5614/5/6A parts all cost $5.75 (100), and the RM5604/5/6A parts cost $10.50, $9.25, and $9 (100), respectively.

EG&G Reticon also supplies Chebyshev highpass- and notch-filter ICs. The devices are fabricated with polysilicon-gate, switched-capacitor technology and are well-suited to such applications as audio telecomm systems, tracking filters, speech processors, and portable biomedical or geophysical instrumentation. Both the RF5611A highpass filter and the RF5612A notch filter cost $5.75 (100).

Many types of telecomm-filter circuits are used so repeatedly that several chip manufacturers have produced special-purpose switched-capacitor filter ICs. One of the most popular applications is PCM transmit/receive filtering to condition speech and data signals for A/D and D/A terminations on telephone

For more information . . .

For more information on the programmable switched-capacitor ICs described in this article, circle the appropriate numbers on the Information Retrieval Service card or contact the following manufacturers directly.

AEG-Telefunken Corp
Box 3800
Somerville, NJ 08876
(201) 722-9800
Circle No 709

EG&G Reticon Corp
345 Potrero Ave
Sunnyvale, CA 94086
(408) 738-4266
Circle No 710

Exar Corp
750 Palomar Ave
Sunnyvale, CA 94086
(408) 732-7970
Circle No 711

Gould/AMI Semiconductors
3800 Homestead Rd
Santa Clara, CA 95051
(408) 246-0330
Circle No 712

GTE Microcircuits
2000 W 14th St
Tempe, AZ 85281
(602) 921-6504
Circle No 713

Harris Corp
Box 883
Melbourne, FL 32901
(305) 724-7800
Circle No 714

Linear Technology Corp
1630 McCarthy Blvd
Milpitas, CA 95035
(408) 942-0810
Circle No 715

Maxim Integrated Products
510 N Pastoria Ave
Sunnyvale, CA 94086
(408) 737-7600
Circle No 716

Mx-Com Inc
4800 Bethania Station Rd
Winston-Salem, NC 27105
(919) 744-5050
Circle No 717

National Semiconductor Corp
2900 Semiconductor Dr
Santa Clara, CA 95051
(408) 721-5000
Circle No 718

Sierra Semiconductor Corp
2075 N Capitol Ave
San Jose, CA 95132
(408) 263-9300
Circle No 719

Vatic Systems Inc
761 E University
Mesa, AZ 85203
(602) 962-8998
Circle No 720

FREE ThinkJet Offer* EXTENDED

Big ticket features.

Small ticket price.

Introducing the HP 54201A Digitizing Oscilloscope.

Now you can make more accurate measurements in less time, at lower cost, with the new HP 54201A... the first $7,900† 200Ms/sec digitizing oscilloscope with 300 MHz bandwidth, automatic measurements, and much more.

Speed setups and get answers at the touch of a button with advanced front-panel controls. Capture two different signals simultaneously at the full 200 Ms/sec rate. Get scaled waveforms on the screen automatically. Be confident in your test results with +/−200 ps time measurement accuracy. Compare one waveform with another, with built-in waveform storage capability. Trigger on complex bus conditions with 27 bits of pattern recognition.** Get permanent records with direct output to printers/plotters. Write and edit test programs easily with HP-OL††. Use the HP Series 200/300, Series 80, or HP 1000 computers for control, thanks to full HP-IB compatibility. And, in general, perform and view complex measurements faster, easier, and more accurately.

If getting best value in an oscilloscope is important to you, get the one with big ticket features and a small ticket price.

Call toll-free 1-800-835-5577 today!

You'll receive a *free* full-color brochure describing the features and capabilities of the HP 54201A in detail. We'll mail our brochure to you right away! In Colorado, call 540-3490 collect. Or contact your local HP sales office listed in the telephone directory white pages. Ask for the electronic instruments department.

CIRCLE NO 49

HEWLETT PACKARD

E115604B

- **Automatic measurements**
- **200 Megasamples per second**
- **300 MHz bandwidth**

Just $7,900†

---

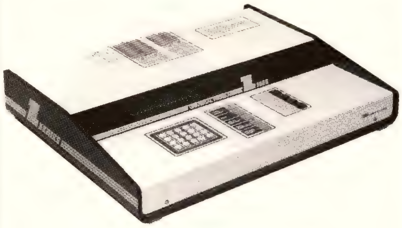
* Receive a FREE HP ThinkJet Printer with every HP 54000 Series Oscilloscope ordered through August 31, 1986. Promotional discount equals the value of the HP 2225A ThinkJet Printer. Offer subject to local conditions.

**HP 54100D only.

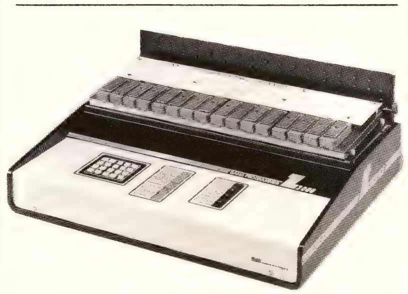
† USA list price only.

††Hewlett-Packard Oscilloscope Language.

AMERICA'S BEST PROGRAMMERS



Z-1000B UNIVERSAL PROGRAMMER
- Over 600 PLDs, EPROMs, EEPROMs, Bipolar PROMs and INTEL MCUs.
- Separate D/A channels for each pin.
- Upgradeable PROM based software.
- Stand alone or PC/XT/AT operation.
- Two independent RS-232 ports.
- 64K or 256K bytes of DATA RAM.
- EXATRON handler interface is standard.



Z-3000 HIGH VOLUME GANG/SET PROGRAMMER
- 14,000 27256s programmed per day.
- 32 EPROMs simultaneously with 1 to 8 DATA BLOCKS.
- 16 Intel or Motorola MCUs at a time.
- 64K to 256K bytes of DATA RAM.

Z-1200B TWELVE SOCKET GANG/SET PROGRAMMER
- 2716 – 27512, 1 to 4 DATA BLOCKS.
- 64K to 256K bytes of DATA RAM.
- Software personality. No plug-ins.

Z-2500B IN-CIRCUIT MEMORY CARD PROGRAMMER
- Programs up to 32 memory cards with EPROMs or microcomputers at a time.
- Two 1.2 Mbyte DSDD floppy disk drives. Optional 20 Mbyte hard disk.
- Turnkey systems include programmer, terminal, custom interface hardware and software.
- Simple menu driven operation.

ZAP SERIES engineering and field service programmers for EPROMs to 27C1024, Intel and Motorola microcomputers.

Z-400 economical bipolar PROM and EPROM programmer.

SUNRISE ELECTRONICS, INC.
524 South Vermont Avenue
Glendora, California 91740
(818) 914-1926

CIRCLE NO 51

trunk lines. GTE Microcircuits and Harris Corp make pin-compatible versions—the G8912B and HC-5512, respectively—of a PCM switched-capacitor filter. Both devices are fabricated with polysilicon-gate CMOS technologies and provide on-chip (sin x)/x correction in the receive filter; the transmit filter consists of a fifth-order elliptic lowpass filter in series with a fourth-order Chebyshev highpass filter. The part rejects 50/60-Hz harmonics and performs antialiasing for 8-kHz sampling systems.

GTE supplies the G8912BPI in a 16-pin plastic DIP for $5.95 (100); a 20-pin PLCC version will be available in July at a slightly higher price. You can obtain the Harris part in the standard industrial versions, HC-5512/A/C, for $6, $7, and $4.58 (100), respectively. The military-grade HC-5512D costs approximately $40 (100).

Full-duplex PSK filtering for Bell-212A CCITT-V.22 modems is another popular special-purpose application that lends itself to switched-capacitor technology. Gould/AMI combines both 212A and V.22 filters, along with on-chip compromise equalizers, in its S3522 and S35212 chips. The parts come in 16-pin and 24-pin DIPs, respectively. Gould/AMI charges $16.90 for the S3522 and $9.50 (100) for the S35212. Alternates for the S35212 are EG&G Reticon's $13.25 (100) RM5632A and Sierra Semiconductor's $9 (100) SC11000/5. Sierra offers an enhanced version of the 35212, the SC11001, which combines an on-chip call-progress monitor with the modem filter functions. For 2400-bps V.22 bis modem filtering, EG&G Reticon supplies the $9.75 (100) RM5635A chip in a 16-pin DIP.

Exar Corp's XR-2126/27/28/29 Series is a family of switched-capacitor Bell-212A and V.22 modem filter chips that are functionally compatible with Gould/AMI's S35212/22 parts. All four filters come in 24-pin DIPs and cost $8.29 (100). In addition to filtering, these devices offer internal analog loop-back functions for diagnostics and call-progress passband-filter outputs (300 to 660 Hz).

Start design with ASICs

Finally, to really save board space, you can create your own filter from switched-capacitor filter ICs based on mask-programmable application-specific ICs from AEG-Telefunken Corp and Vatic Systems (both companies are subsidiaries of Thomson-CSF Components Corp of France). You can build semistandard chip designs, for example, from AEG Telefunken's U3408M. You can specify eighth-order lowpass, bandpass, and highpass filters having a 40-kHz max bandwidth by programming metal masks. First silicon for a semistandard U3408M chip takes about three weeks and costs around $9 to $10 (100). Samples of the U3409M, a similar device that specs a 50-kHz bandwidth, are available now. **EDN**

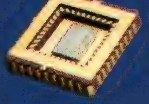
References

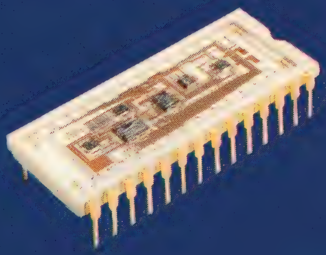
1. Lacanette, Kerry, "Universal switched-capacitor filter lowers part count," *EDN*, April 3, 1986, pg 139.
2. *Switched-Capacitor Filter Handbook*, edited by Kerry Lacanette, National Semiconductor Corp, Santa Clara, CA, 1985.
3. Davis, A M, and Small, W Timothy, "Switched-capacitor ICs simplify filter design," *EDN*, June 14, 1984, pg 197.

Article Interest Quotient
(Circle One)
High 503 Medium 504 Low 505

11-Bit Flash Converter

MPS Single Chip . . . vs. . . . Other's Hybrids





Compare power, price, reliability, space, LCC packaging, and specs.

Stop spending hundreds of dollars on large, complex 10-and 12-bit hybrid flash converters. Now you can benefit from the world's only, one-chip 11-bit flash. Not only does the MP7685 out perform the hybrids, but it's available to full mil specs and with LCC packaging. Two devices in series provide 12-bit resolution and 2 devices in parallel double the throughput rate to 4MHz.

Micro Power's line of flashes can satisfy all of your design requirements. Check these out:
11-bit MP7685 (2MHz speed, ±1/2 bit accuracy),
8-bit MP7684 (20MHz speed, ±1/2 bit accuracy),
8-bit MP7683 (10MHz speed, ±1/2 bit accuracy),
6-bit MP7682 (30MHz speed, ±1/4 bit accuracy).

Micro Power's proprietary bulk silicon molybdenum gate CMOS converters provide high performance and powerful solutions for flash applications. These devices meet commercial, industrial, and military temperature ranges. All are available with MIL-STD-883 processing, and are CMOS microprocessor compatible.

Samples, data sheets, applications boards and applications support are immediately available. Send the coupon or phone your local representative or distributor. MPS is the leader in data acquisition ICs, refractory gate MOS technology, and now flash converters.

MICRO
POWER
SYSTEMS

3100 Alfred Street
Santa Clara, CA 95054
(408) 727-5350

To: **Micro Power Systems,** 3100 Alfred St., Santa Clara, CA 95054

☐ Send Flash Converter data ☐ Have Applications Engineer call

Application: __________

Estimated Yearly Usage: __________

Name/Title

Company

Address

City State Zip

( )

Phone EDN62686

CIRCLE NO 53

NEWS FROM PHILIPS

INTEGRATED CIRCUITS □ SEMICONDUCTORS □ ELECTRON TUBES □ COMPONENTS □ ASSEMBLIES □ MATERIALS

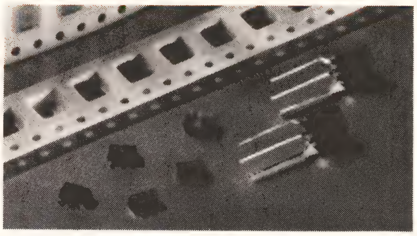
P-CHANNEL VERTICAL DMOS FETs COMPLEMENT POPULAR N-CHANNEL TYPES

We are introducing enhanced p-channel types to complement several of our popular n-channel vertical DMOS FETs, giving manufacturers extra flexibility in switching applications. Like their n-channel counterparts, the new p-channel FETs are available in both TO-92 for standard mounting procedures and in SOT89 for surface mounted assembly, thereby giving OEMs even more freedom of design choice.

The new BST100 (in TO-92) and the BST120 (in SOT89) complement the n-channel BS170A, and the BST110/BS250 (TO-92) and BST122 (SOT89) complement the BS170. As with our n-channel DMOS FETs, a vertical crystal configuration results in a very low drain-source ON resistance, for example typically 4,5 Ω for the BST100/120 with a gate-source voltage of 10 V. This makes for faster, more efficient switching compared to bipolar transistor switches. Another advantage over bipolars is the complete absence of second breakdown.

Thanks to very short active channels, switching times are fast, a typical turn-on time for the BST110/122 is just 4 ns under rated conditions. In addition, the interdigitated electrode structure of the crystals minimizes input capacitance whilst optimizing switching behaviour. A low threshold voltage means that the FETs are directly TTL- and CMOS-compatible.

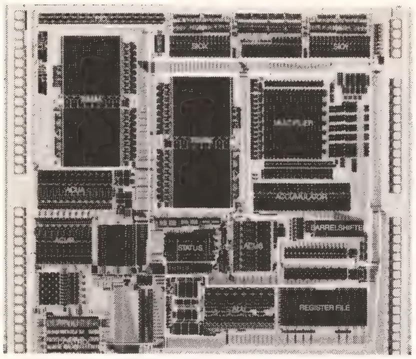
Application areas include high-speed line and transformer drivers, relays, display drivers, pre-drivers for SMPS, high-frequency inverters, and many other switching applications in the telecommunications, telephony and general industrial market segments.



The BST100 and BST120 are rated for a maximum drain-source voltage of -60 V, the BST110/BS250 and BST122 for -50 V. The BST100, BST110/BS250 TO-92 types are supplied in bulk or taped on reels, the BST120 and BST122 SOT89 types are supplied in bulk or on 12 mm tape for immediate loading on to automatic placement machines.

CIRCLE 4

HIGHLY-PARALLEL CMOS DSP PERFORMS 48 MILLION OPERATIONS PER SECOND



Philips is launching a 2 μm, single-chip, CMOS Digital Signal Processor (DSP) capable of eight million instructions per second (8 MIPS) and up to six concurrent operations in each instruction – an equivalent total of 48 million operations per second. The high throughput of the PCB5010 results from a highly parallel, pipelined Harvard architecture consisting of two 16-bit data buses and five functional sections all working in parallel. The new DSP offers a short instruction cycle time of 125 ns. A ROMless version, the PCB5011, is available for emulation and small-scale production runs. The new devices form the first members of a whole family of DSPs, designated the SP50 family.

The PCB5010 is optimized for programming convenience – programming is about an order of magnitude faster than with previous single-chip DSPs. This is achieved due to the fact that each functional section falls under the control of a different field within each 40-bit instruction word. The programmer need concentrate on only one field (i.e. one functional section) at a time rather than dealing with unwieldy instructions that control several functions together.

Benchmarks show a two to sixfold improvement in overall performance over previous single-chip DSPs. As well as considerably enhancing existing applications implemented with earlier generation DSPs, the PCB5010 brings impressive processing power to a whole range of new applications which were difficult (or impossible) to implement with the earlier single-chip devices.

In addition, by using the PCB5010 in place of a conventional multi-component DSP, manufacturers drastically reduce costs, as well as space and power requirements, at the same time achieving higher performance and reliability.

Philips is making software and hardware development tools available to facilitate program development for such diverse applications as speech processing, engine control, mobile automatic telephony and digital HiFi audio. As well as dedicated applications, the PCB5010 can also be used in many system configurations such as a stand-alone DSP system, a host-controlled DSP system, and multi-DSP systems with processors in series, in parallel, or both.

The five functional sections are: a program control unit; a multiplier-accumulator with barrel shifter and format adjuster; an ALU with a scratchpad register file; data and program ROM, two data RAMs and three independent address computation units; and a serial/parallel I/O section consisting of five I/O interfaces.

Philips plans to extend the SP50 family to include DSPs upward and downward compatible with the PCB5010/11, and DSPs dedicated to the needs of particular segments of the market. Peripheral devices such as analog interfaces will also be included. The new devices operate from a single 5 V power supply. Two temperature ranges are planned: PCB5010/5011 for operation between 0 and 70 °C; and PCF5010/5011 for operation between -40 and 85 °C. The PCB5010 is in a 68-pin PLCC and the PCB5011 is in a 144-pin grid array.

CIRCLE 43

PHILIPS

Electronic
components
and materials

THE COMPLETE COMPONENT COMPANY

Philips Electronic Components and Materials Division, 5600 MD Eindhoven, The Netherlands

HIGH-VOLTAGE TRANSISTORS OFFER IMPROVED SWITCHING SPEED

By restructuring an established transistor for improved switching speed, we are now able to supply a new series of fast, high-voltage transistors.

The BUX99, PH13002 and PH13003 are general purpose switches particularly useful in lighting applications.

All the new devices are based on our BUX99 crystal, itself an updated version of our BUX86. The new transistors are separately specified so as to form a complementary series. Using the BUX99 as an example, typical switching times are 0,5 μs (turn-on time) and 0,4 μs (fall time). The new devices are encapsulated in the well-known TO-126. Collector-emitter voltage ratings go up to 730 V, maximum d.c. collector current is 1,5 A for all the types. The PH versions have a high total power dissipation of 40 W maximum (up to an ambient temperature of 25 °C). Forward current gain ranges from 16 to 50 for the BUX99 and from 8 to 40 for the PH types.

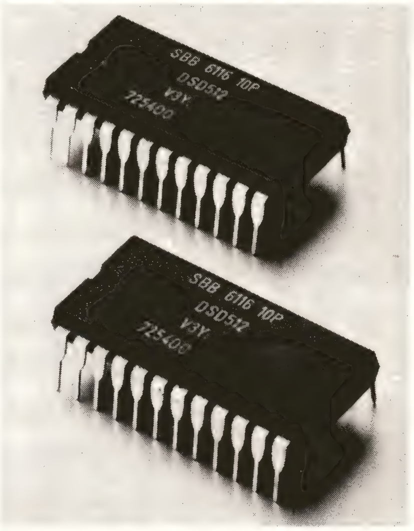
CIRCLE 82

FASTER VERSION OF INDUSTRY-STANDARD 16 KBIT SRAM CONSUMES LESS POWER

We are supplying an enhanced CMOS version of the industry-standard 6116 static RAM with such specification improvements as shorter access times and power consumption as low as 30 μW in standby mode. In addition, the 16 Kbit SBB6116 is available in two different versions giving a choice of access times of 100 ns and 120 ns. Pin compatibility with the standard 6116 and with the 2726 EPROM makes for a wide range of applications in microprocessor peripheral memory design.

The 2 K x 8-bit device is edge-triggered (i.e. address-activated) so that power consumption depends on the amount of access. Typical active power consumption is only 100 mW. As the device operates from a 5 V supply, all inputs and outputs are directly TTL-compatible. The SBB6116 is suitable for applications where an emergency battery back-up is used.

A common 8-bit input/output interface is controlled by an output enable pin. Easy memory expansion is available via a chip select input in low-power standby mode. The inputs/outputs are protected against electrostatic discharge. The three-state outputs feature wired-OR capability.



Fabricated in a double poly process, the SBB6116L-10P (100 ns) and SBB6116L-12P (120 ns) are available in a 24-lead plastic DIL (SOT-101A). Operating ambient temperature range is 0 to 70 °C. Storage temperature range is −55 to +125 °C.

CIRCLE 121

VIDEO PROGRAMMING SYSTEM ELIMINATES INCORRECT RECORDING

A two-chip video programming system (VPS) from Philips eliminates accidental recording of incorrect tv programmes by video tape recorders. The chip-set, consisting of the SAA5235 dataline slicer and the SAF1135 dataline decoder, extracts stop/start information from the broadcast signal and makes it accessible to the VTR via an on-board I^2C bus interface. As the dataline receiver system is independent of time, it ensures that only the desired programme is recorded, unaffected by delays or changes in transmission schedules.

Until now VTR users have had to program their equipment with the start and stop times of the required tv transmission. Delays or re-scheduling results in the wrong programme being recorded. To overcome this problem broadcasters in West Germany, Austria, Switzerland and Holland agreed to insert a special code within the frame blanking period which denotes precisely the begin and end points of specific programmes. Transmission of the VPS code started at the International Berlin Broadcasting Exhibition in August 1985. Other European countries are planning to follow suit.

The binary VPS code is transmitted in line 16 of every first field. The SAA5235 dataline slicer receives the colour video blanking signal and separates out the dataline signal. The circuit also regenerates both line 16 VPS information and the dataline clock. The dataline data and the dataline clock are fed to the SAF1135 dataline decoder via coupling capacitors.

The SAF1135 checks the run-in code, the start code and the biphase code of the VPS signal in line 16. If all checks are positive the circuit makes word 5, 11, 12, 13, 14 accessible for the I^2C bus. The information will be read out by the timer microprocessor to overrule the fixed, pre-programmed timer.

The bipolar SAA5235 comes in a 28-pin plastic DIL, operates from a supply voltage of 12 V and consumes typically 70 mA current. Implemented in a low-power CMOS process, the SAF1135 has a typical current consumption of 1 mA and requires a typical supply voltage of 5 V. The SAF1135 is in a 14-pin plastic DIL. Operating temperature range for both circuits is 0 to 70 °C.

CIRCLE 160

PHILIPS

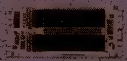
Our new, 1K × 4 static RAM.

0.8 micron CMOS shoves 4K SRAM speed down to 15ns, power down to 550mW, die size down to 6634 sq. mil, and

2.0 micron 1K × 4 SRAM, an industry standard, shown ≈ 4 × larger than actual size. It goes 35ns.

shoves 2.0 micron IC competitors, technically speaking, two years further behind.

Cypress Semiconductor. We've been shipping 1.2 micron CMOS in volume for two years. And now we have 0.8 micron CMOS. The clear industry leader in getting small, fast . . .



1.2 micron Cypress Semiconductor 1K × 4 SRAM, also shown ≈ 4 × larger than actual size, is smaller, runs faster, uses less power. It goes 25ns.

0.8 micron 1K × 4 SRAM, also shown ≈ 4 × larger than actual size. Since we can't make electrons go any faster, we've shortened the distance they have to travel. Result: 15ns.

Our new 4K SRAM is just one of over 80 reasons why design engineers who design performance will want our new, fatter, faster data book.

For over two years, our growing family of 1.2 micron CMOS parts has been delivering big benefits to high performance designers.

But you can never have too much speed, or too little power.

So we're stepping over the one micron line.

First, with the 0.8 micron 4K SRAM.

And there are more sub-micron CMOS performance products on the way.

Either geometry—our 1.2 micron or our new 0.8 micron—delivers the same Cypress Semiconductor advantages. 0.8 micron is simply a matter of degree, and not kind.

Advantages that include:

SPEED. Faster than any other TTL-compatible circuit.

LOW POWER. CMOS. Speed without heat.

RELIABILITY. No latchup. ±10% V_{CC} tolerance, 2001 volts ESD tolerance: *No problem.*

You get a choice of packaging. You get parts designed to run over the full military temperature range (and available manufactured to military specifications).

We have a whole book full of tools you can use to build *faster, cooler* systems.

CMOS High Speed SRAM Family

Featuring the *fastest* (15ns) 4K static TTL-compatible RAMs you can buy. Plus a variety of 15ns, 25ns, 35ns, and 45ns parts, too. Nibble-wide, bit-wide, byte-wide, ranging from 64-bits through 16K-bits. Low active power. Low standby power—many parts include auto-power-down when deselected. A superset of separate I/O functions provides a design edge for improving overall performance.

CMOS High Speed PROM Family

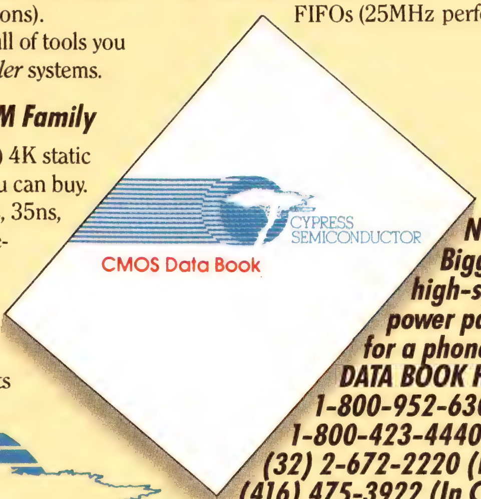
Surpassing bipolar with one of the *fastest* registered PROMs at ½ bipolar power, or less. Parts feature speeds to 25ns set-up, 12ns clock-to-output; all with low CMOS power. Byte-wide family available in 4K, 8K, 16K, 64K densities. Available with or without registered outputs. EPROM memory technology permits 100% testing of data bits before packaging, to provide optimum programming yields, plus *windowed parts* for the convenience of reprogramming.

CMOS High Speed PLD Family

Featuring 25ns HALF-power 80 mA *windowed* 22V10 EPLD—the new high speed PAL® device standard. The family also includes QUARTER-power 45mA PAL 20 parts, and 55mA PAL 24 parts, both available at 25ns speeds and in windows. All cells 100% functionally tested. All parts with up to 75% power saving over bipolar.

CMOS High Speed Logic Family

World's fastest 4-bit-slice and 16-bit-slice microprocessors. 16 × 16 multipliers at 38ns, none faster. Plus sequencers, controllers, DSP circuits, and more. Also, fastest available 4-bit and 5-bit cascadeable FIFOs (25MHz performance).



New! Bigger! 80 high-speed, low-power parts. Yours for a phone call.

DATA BOOK HOTLINE:
1-800-952-6300.
1-800-423-4440 (In CA).
(32) 2-672-2220 (In Europe).
(416) 475-3922 (In Canada).
Ask for Dept. C61.

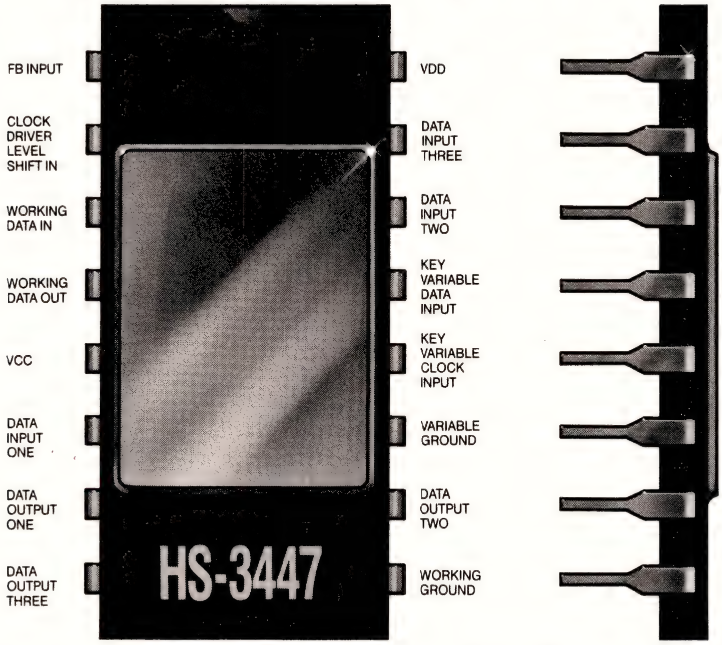
CYPRESS
SEMICONDUCTOR

[illegible]

[illegible]

WANTED CYPHER-1™

Our NSA-endorsed encryption chip: more speed, less space than DES.



Now the high-speed data encryption chip once reserved for protecting America's defense secrets is available to communications equipment makers to protect sensitive but unclassified government or government-derived information, the loss of which could adversely affect the national security interest.

The Harris CYPHER-1™ circuit is embeddable and built with our proven low-power CMOS process. Compared with the decade-old DES chip, CYPHER-1™ is nearly 50% faster (20 megabits/second)—and its smaller size (16 pins versus DES' 40) makes it flexible enough to interface with almost any communications channel.

You'll find the CYPHER-1™ is the perfect encryption circuit in EDP applications—computer-to-computer links, telecommunications, satellite communications and local area networks.

The CYPHER-1™ circuit encrypts/decrypts via a serial data stream, rather than using the slower traditional block cypher process. In addition to cryptosecurity, the CYPHER-1™ chip is also perfect in systems using spread spectrum transmissions. Use it to build-in immunity to frequency jamming and signal interception in electronic warfare applications.

It's available in production quantities now.

DES is yesterday's technology. CYPHER-1™ is tomorrow's. Call Harris today.

For a data sheet and application information, call (305) 729-5757. Or write: Harris Custom Integrated Circuits Division, P.O. Box 883,
MS 53-175,
Melbourne, Florida
32902-0883.

HARRIS

CYPHER-1™ is a trademark of Harris Semiconductor.

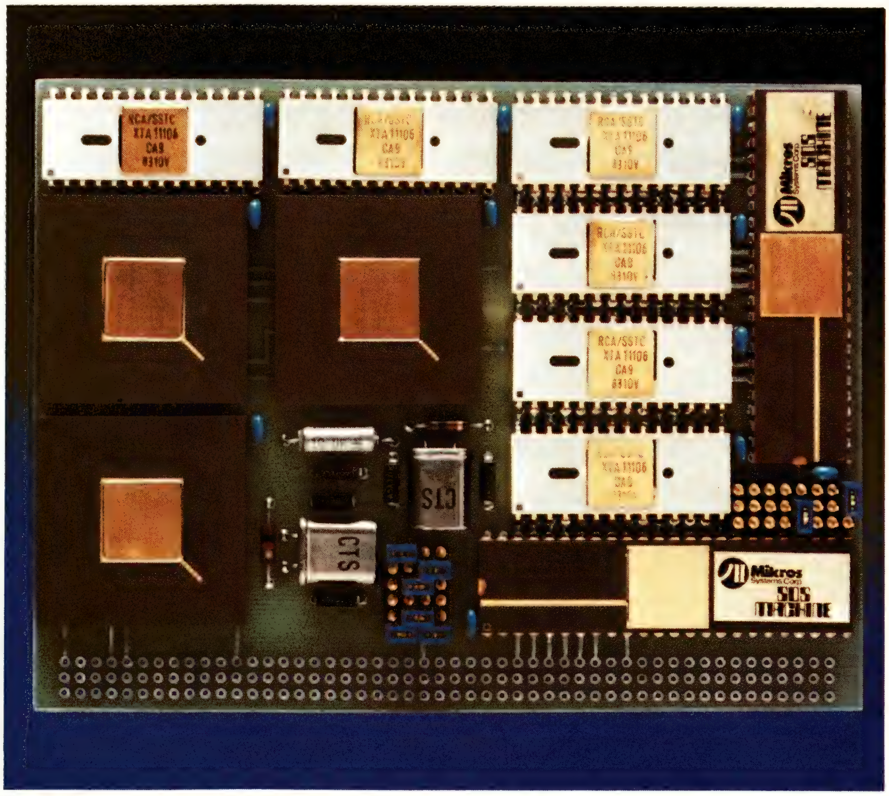
CIRCLE NO 56

Harris Semiconductor: Analog · CMOS Digital · Gallium Arsenide · Semicustom · Custom

FOR YOUR INFORMATION, OUR NAME IS HARRIS

Development tools and VLSI chips help you design to military standards

Chris Terry, *Associate Editor*



Eleven VLSI chips provide all the 1750A mandatory functions *in less than 20 in² on this processor board from Mikros Inc. The CMOS and SOS chips are hardened to resist radiation at strategic levels.*

The latest advances in VLSI design techniques have led to reductions in the size and price of MIL-STD-1750A processors, and, as a consequence, developers of 1750A-compatible systems and peripherals can now afford to design on examples of the target system. What's more, the availability of 1750A development systems and emulation software now brings the development of programs for those systems and peripherals to VAX minicomputers and even IBM PCs.

Until approximately 18 months ago, you would have found it difficult to develop equipment that interfaced with a military computer conforming to either the US Air Force's MIL-STD-1750A standard (for flight controllers or combat systems), or the Navy's MIL-STD-1397 standard (for tactical data systems). You'd have preferred to have an example of the target system on which to develop and debug the new product, but your company might well have balked at the prospect of paying a quarter- or perhaps a half-million dollars for it.

You might then have considered buying a commercial-grade development system instead, but you wouldn't have been able to find one. In the end, you'd have had to write your own programs to emulate the target computer, and you'd have had to run them on your company's mainframe to ensure that they were fast enough to handle real-time data. And more trouble might have arisen if one of your critical debugging sessions conflicted with use of the computing facility by some other department.

As a consequence of these obstacles, only large, established makers of systems and peripherals could serve the military market. But miniaturization promises to open up that market. Within the last year, several IC manufacturers have implemented the MIL-STD-1750A instruction set in VLSI chip sets developed for the Pentagon's Very High Speed Integrated Circuits (VHSIC) program. The bipolar, NMOS, and SOS (silicon-on-sapphire) fabrication technologies employed by the IC companies yield chips that consume little power, have high resistance to radiation, and operate reliably over the full military temperature range of −55 to +125°C. The availability of these chip sets now allows the IC companies and other manufacturers to offer single-board 1750A computers, as well as complete 1750A development systems, at economical prices.

Better yet, new emulation systems allow you to develop your programs on a VAX minicomputer or an IBM PC/XT or PC/AT, download the programs to an in-circuit emulator, and then debug the target system with the aid of the facilities provided by the VAX or PC. The software provided with tools of this kind allows the host to emulate either the CPU of the target system or the peripherals with which a device under development will work.

Mikros brought its SOS MKS1750/S chip set to market early

The OB68K/VME1-M™ is a ruggedized VME 68000 single board computer, derived from our highly successful OB68K/VME1™. We have designed the OB68K/VME1-M with VLSI components that are available in standard commercial, extended temperature range commercial and full MIL STD 883B grades (all other components are standard as MIL STD 883B). We have also fitted the board with a stiffener bar to increase its resistance to shock and vibration. This makes our OB68K/VME1-M ideal for applications where you are concerned about vibration, temperature extremes or reliability. We can also conformally coat the board to make it resistant to most environmental contamination. The OB68K/VME1-M is even tough enough to use in many military applications, with environmental testing and certification the responsibility of the purchaser.

You can specify the grade of VLSI parts you need and whether conformal coating is required. You can tailor the OB68K/VME1-M to meet your needs at the lowest possible cost.

The Omnibyte OB68K/VME1-M features the following:

- 10 MHz 68000 (other speeds available)
- (2) multiprotocol RS232C serial ports.
- (2) 8-bit parallel ports.
- System controller functions.
- (6) pairs of 28-pin sockets for EPROM or SRAM (up to 512KB EPROM, 128K SRAM).

To obtain a free data sheet or further information, contact our Marketing Manager, Peter Czuchra today!

OMNIBYTE™

A Look At Today... A Vision Of Tomorrow.

OMNIBYTE CORPORATION
245 W. Roosevelt Road
West Chicago, IL 60185-3790
(312) 231-6880
Intl. Telex: 210070 MAGEX UR

CIRCLE NO 57

in 1985. The basic set comprises eleven chips: two MKS16 processors, one of which operates as a register file; six control ROMs; and three gate arrays. One array operates as a Multibus-compatible bus interface, another is an interrupt controller, and the third is an emulation controller. These eleven chips implement all of the mandatory functions of MIL-STD-1750A. One additional gate array (the MMU) and four page-register RAM chips effect the 1750A memory-management option. Using these 16 chips, you can build a complete processor that occupies less than 20 in^2, dissipates 1W, withstands 10^{11} rads/sec transient to a total dose of 2×10^5 rads, and performs 2M operations/sec, based on the Discrete Avionic Instruction Set (DAIS) floating-point mix of mathematical operations. (All operations/sec specs mentioned in this article are based on the DAIS mix.)

Fairchild's F9450 chip set comprises three I^{3}L chips: the F9450 CPU, the F9451 MMU, and the F9452 block protect unit (BPU). The F9450 implements all of the mandatory functions of MIL-STD-1750A and provides 32- and 48-bit floating-point arithmetic on chip, as well as two programmable timers and 16 levels of vectored interrupts for real-time applications. The clock speed is 20 MHz, yielding a processing speed of 1.5M operations/sec. The initialization sequence at power-up includes a self-test sequence (mandatory under VHSIC rules) that checks all major functions of the processor and returns a fault bit if an error is detected. If the error is unrecoverable, a pulse appears on a special output line that you can connect to an alarm. The F9450 directly addresses 2M words of memory, and the MMU expands the address space to 16M words. Each of the three chips comes in a 64-pin DIP. A surface-mount package is optional.

Delivery of Performance Semiconductor Corp's Pace1750A chip set is scheduled to begin later this year. Both 20- and 30-MHz versions will be available. The 30-MHz version performs approximately 2M operations/sec. The technology used to fabricate this chip set and related products is called Pace (Performance Advanced CMOS Engineered) and was developed by Thomas Longo, formerly of Fairchild and now president and cofounder of Performance Semiconductor Inc.

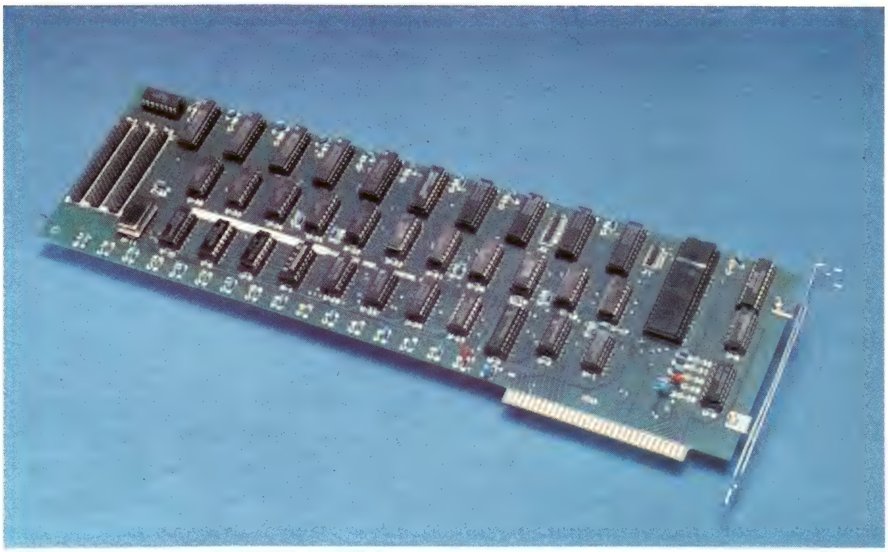
Longo says that Pace provides greater device density than currently available CMOS technology does because of its 2.7-μm metal pitch; typical 1.2-μm processes have a 4-μm metal pitch. The 0.8-μm channels allow fabrication of devices with internal gate delays of only 0.5 nsec (loaded) or 0.2 nsec (unloaded). Performance Semiconductor is offering the chips as drop-in alternatives to the Fairchild parts. A 40-MHz part for the commercial temperature range is under development.

Pipelining for high speed

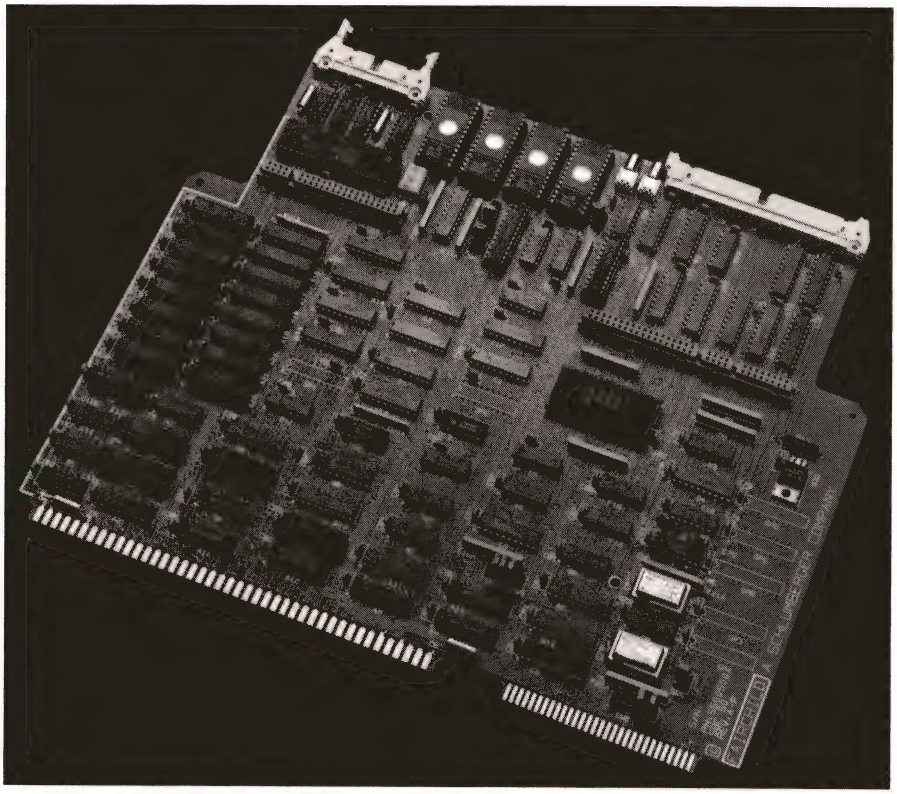
The Texas Instruments 1750A processor is a single Schottky-transistor-logic chip that implements a superset of the MIL-STD-1750A instruction set; you can disable the extra instructions if they're not required. The processor employs pipelining and parallel bus synchronization to achieve a processing speed of approximately 3.3M operations/sec. Radiation-hardened to the strategic level, it works in conjunction with NMOS static RAM hardened to the tactical level (the RAMs are available from TI, in 8k×9-bit chip form).

The chip includes circuitry that tests all logic on the board and is capable of detecting 95 to 98% of all possible faults. The test runs when power is turned on or at any time thereafter under software control, and it returns a 1-bit go/no-go completion code. The chip's self-test circuitry executes algorithms, newly developed by Professor Szewerenko of the SEAFAC testing and certification facility, that exercise 1750A functions.

From McDonnell Douglas Astronautics comes the MD281E extended processor module, a collection of 22 CMOS/SOS VLSI chips mounted on a 2.4×5-in., 100-pin, ceramic DIP. This module implements all of the MIL-STD-1750A functions, including memory management of a physical address space as large as 1M words and write-protection of 1k-word blocks. The execution-unit chip provides all of the computational functions of the



You can develop military hardware and software *on your IBM PC/XT with the aid of this MIL-STD-1397 plug-in interface board from Sabtech Industries.*



You can base a MIL-STD-1750A development system on this Multibus board *from Fairchild. Serial I/O ports let you attach a console and peripherals, and the Multibus lets you address off-board memory.*

processor. The control-unit chip contains the microcode and controls machine execution sequences; when you order the part, you can specify that the vendor include extra functions in the firmware. The interrupt-unit chip services interrupts and the three system timers. It also handles detection and notification of system and processor faults.

Used in conjunction with 200-nsec memory, the MD281E module performs 884k operations/sec. The module is intended primarily for military and space avionics applications that require rugged general- and special-purpose processors for real-time information processing, including the processing of sensor data and the control of weapons systems.

Plug into existing Multibus

The ready availability of VLSI chips implementing the 1750A instruction set has eliminated the most difficult task that formerly faced the designer of embedded military computer systems—the design of the CPU itself. Furthermore, Fairchild, Mikros, and other vendors now offer single-board computers, as well as complete development systems, based upon these chip sets. Consequently, designers of software and peripheral devices now have at their disposal relatively inexpensive hardware that duplicates exactly the target machine that will run their software or drive their new peripheral.

Fairchild's SBC-50 board contains the F9450 CPU chip, RAM, EPROM, serial ports, and direct links to the F9450's bus signals. In addition, compatibility with the Multibus simplifies the addition of off-board memory and expansion of the SBC-50's own I/O capabilities. Also, a native (1750A) high-speed expansion bus provides a direct connection between the F9450's internal bus signals and a designer's prototype board. Consequently, the F9450 can address memory that is on the SBC-50, on the native bus, or on a Multibus memory module.

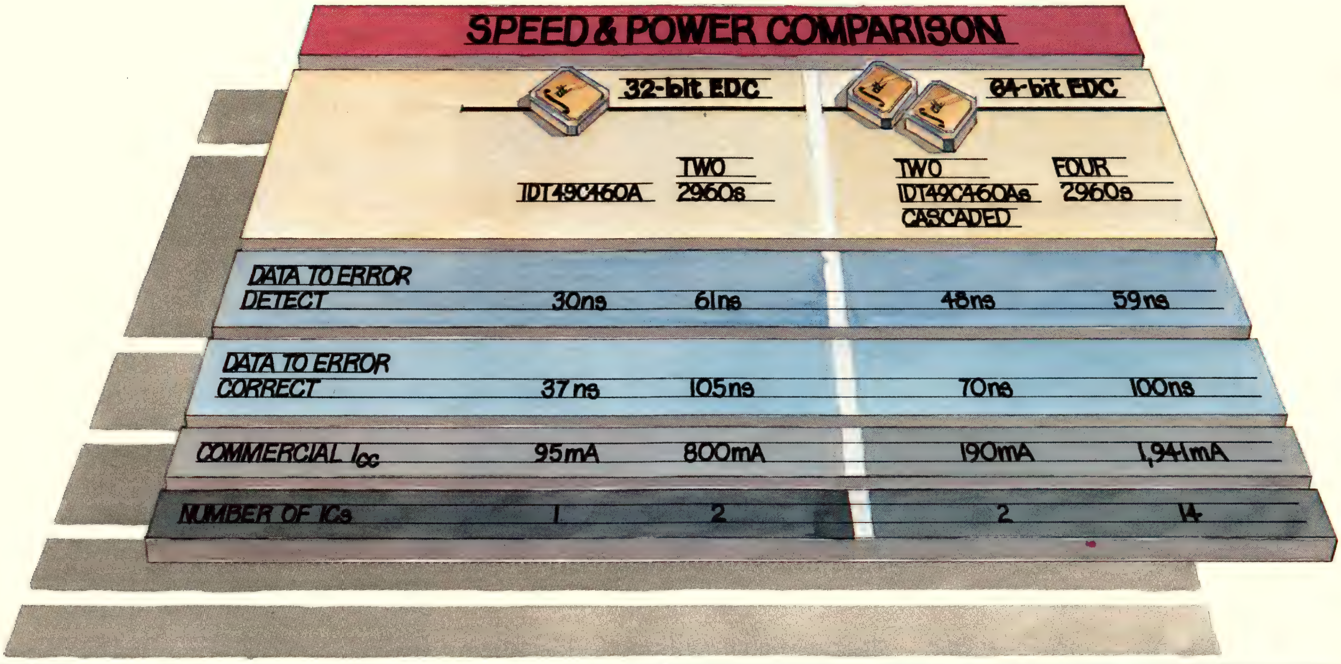
The onboard memory is organized as 64k 16-bit words of high-speed, static, dual-port RAM that operates at the maximum clock speed with no wait states. The dual-port feature renders the memory accessible to bus masters on the native bus and on the Multibus, and to the F9450. An optional MMU/BPU module that plugs into the SBC-50 expands the F9450's address space to 1M words and provides write protection of memory blocks as small as 1k words. Onboard firmware includes an EPROM-resident monitor that provides user control and debugging facilities and allows you to download code from a VAX host computer. You can create the code by means of the company's F9450 macroassembler, the Macro-50, which runs under VAX/VMS. Two additional sockets allow you to add your own EPROM-resident functions, to a maximum of 16k words.

The SBC-50 has two RS-232C serial ports that accommodate software-selectable data rates as high as 19.2k bps for asynchronous communication with external devices. An iSBX-compatible I/O expansion bus accepts multimodule boards for expansion of the I/O capability. The SBC-50 costs $7350, and the MMU/BPU module costs $500.

Mikros's MKS1750/M, a single-board, Multibus-compatible computer based on the MKS16 chip set, implements all of the mandatory functions of MIL-STD-1750A. The Multibus interface supports DMA, multiprocessor configurations, and as many as eight levels of user interrupts. The processor can directly address as many as 64k words of RAM. Mikros also offers a 2-board version, the MKS1750/MO, which implements several options, including memory management for memory as large as 1M words, as many as 16k words of start-up firmware in ROM, a console interface, two interrupt registers, and two timers. Prices are $8500 for the MKS1750/M and $10,500 for the MKS1750/MO.

When performance counts

Announcing 32-bit EDC: CMOS cool and blazing fast



SPEED & POWER COMPARISON

	32-bit EDC		64-bit EDC	
	IDT49C460A	TWO 2960s	TWO IDT49C460As CASCADED	FOUR 2960s
DATA TO ERROR DETECT	30ns	61ns	48ns	59ns
DATA TO ERROR CORRECT	37ns	105ns	70ns	100ns
COMMERCIAL I_{CC}	95mA	800mA	190mA	1,941mA
NUMBER OF ICs	1	2	2	14

Twice as fast as two 2960s at 1/8th the power, it's hard to believe that 32-bit EDC is now this fast.

The IDT49C460A is functionally equivalent to two 2960s.

But that's where all comparisons end if you're designing with EDC.

Because the IDT49C460A is twice as fast as 2960 based designs.

Cascadable to 64-bits. Two IDT49C460As perform 64-bit EDC without additional MSI. Only IDT provides this capability.

Superior to the ALS632. The IDT49C460A is 25% faster while consuming 155mA less power than the ALS632. And the ALS632 cannot be cascaded, not even with additional MSI.

Available now. Commercial/military in a 68-pin PGA ☐ 68-pin "shrink" DIP (600 mil, 70 mil pin-centers) ☐ two 68-pin LCCs (a "fine-pitch" 25 mil pin-center and a 50 mil pin-center).

Accurate. Enhance data integrity in your main memory system. Correct all single-bit errors. Detect all double and some triple-bit errors.

Architectural enhancement. Separate byte enables for simplified byte operation and faster byte writes.

Diagnostics. All IDT EDC products contain built-in diagnostic circuitry that verifies proper EDC operation.

16-Bit EDC Speed & Power Comparison

	IDT39C60A	2960A	IDT39C60-1	2960-1	IDT39C60	2960
Data to error detect	20ns	N/A	25ns	25ns	32ns	32ns
Data to error correct	30ns	N/A	52ns	52ns	65ns	65ns
Commercial I_{CC}	85mA	400mA	85mA	400mA	85mA	400mA

Speed leadership in 16-bit EDC.

We also make 16-bit EDC in three speeds: the IDT39C60A, IDT39C60-1 and IDT39C60.

The IDT39C60A is unquestionably the fastest TTL compatible CMOS 16-bit EDC in the world. And more than just some "specs on paper," it's *available now.* Clearly establishing a new standard that others can only hope to achieve.

The IDT39C60-1 and IDT39C60 are equal in speed to the 2960-1 and 2960.

All are pin compatible and functionally equivalent to the bipolar 2960s, but have greater output drive, while consuming only 1/4th the power.

Available now. Commercial/ military product in 48-pin and 52-pin DIPs and 52-pin LCCs. Or cut board space in half with our 48-pin "shrink" DIP (400 mil, 70 mil pin-centers).

Cascadable. Up to 64 bits.

CEMOS and MICROSLICE are trademarks of Integrated Device Technology.

May we be of assistance?
Contact our local representative, call **1-800-IDTCMOS,** or fill in the bingo for a copy of our *Application Note* explaining how to use 16- and 32-bit EDC.

Also ask for our *Product Selector Guide* on CEMOS™ **MICROSLICE,™** (bit-slice microprocessor products) **Subsystems, Memory Interface Logic, Digital Signal Processing Circuits** (multipliers, MACs and FIFOs), and one of the fastest, broadest lines of **Static RAMs** in the world.

Leading the CMOS Future

Integrated Device Technology
3236 Scott Boulevard
Santa Clara, CA 95054-3090
(408) 727-6116
TWX 910-338-2070

CIRCLE NO 58

***Your IBM PC/AT can serve as a development** and debugging workstation for MIL-STD-1750A embedded computer systems when you use an emulator interface from Mikros.*

Several manufacturers offer complete 1750A computer systems for development purposes. Typical of these products is the Mikros MKS1750/C, based on the MKS1750/M and /MO boards. Like the board products, the MKS1750/C is compatible with the Multibus, and it's available in a wide range of configurations that can include as much as 1M words of memory, a console, and mass storage. The computer comes with resident monitor/executive software that supports both debugging and program downloading from a larger host. Other available development tools include an assembler, a linking loader, and a Jovial compiler. Prices start at $18,800.

M/A-Com Linkabit Inc offers the LMC 1750A military-standard system in two versions. One is a general-purpose computer with 1M words of memory and as many as 440 I/O lines; the other is a Tempest-hardened system that comes with multilevel security software and red/black data separation. The firmware comes in the form of EEPROM or UV-EPROM. Built-in fixed- and floating-point arithmetic hardware and a 1k-word cache memory allow the processor to perform 750k operations/sec. A programmable I/O processor handles RS-422, RS-232C, or MIL-STD-188C asynchronous serial communications; the processor also controls A/D, D/A, and synchro-to-digital converters.

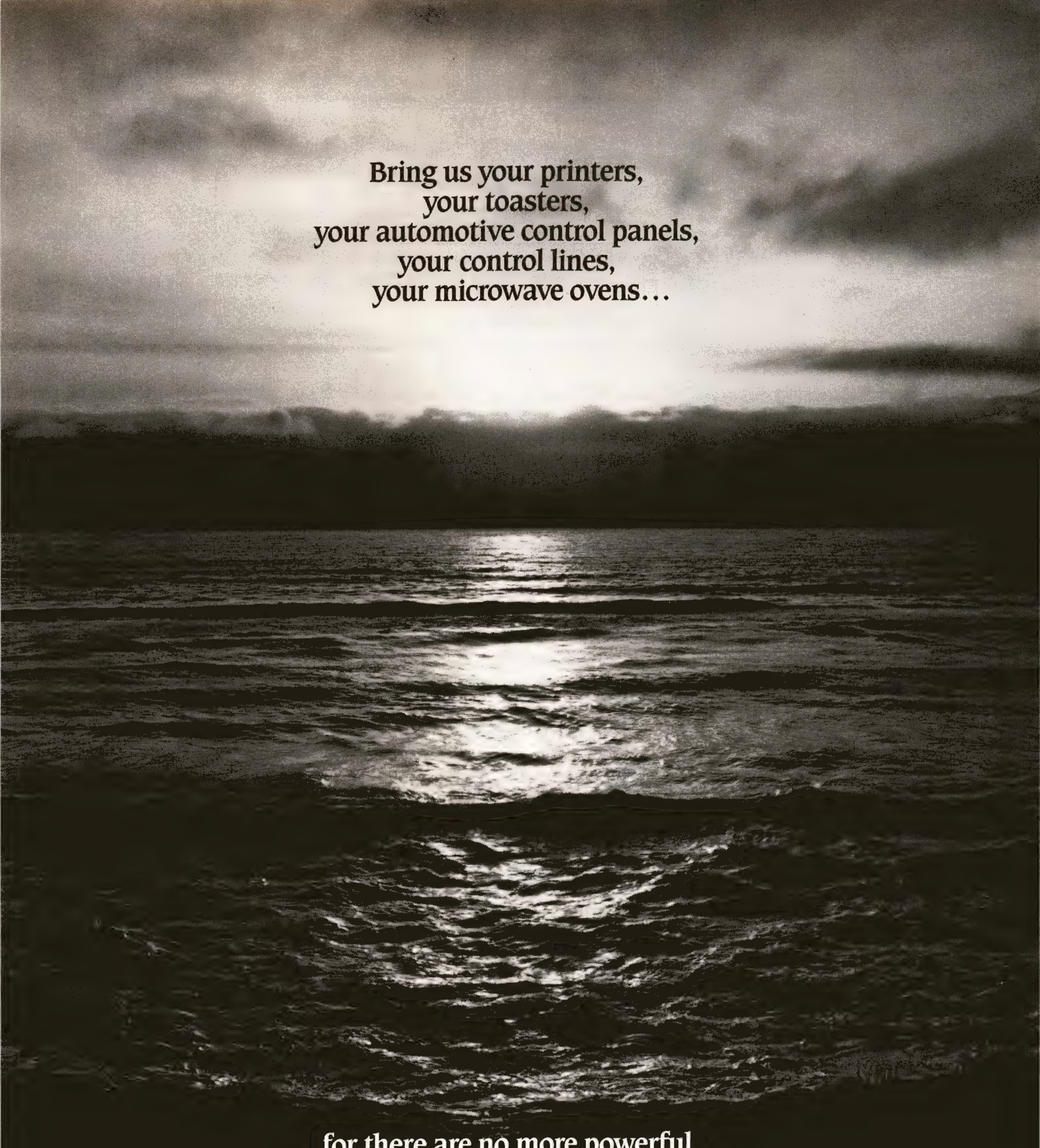
The computer is housed in an ATR chassis that can have as many as 24 slots and connectors for the 440 I/O lines. The standard chassis is convection cooled, but the company can supply an optional mounting tray equipped with fans for forced cooling. You can separate the switching-power-supply module from the main chassis. Software support includes a Jovial J-73 compiler, a macroassembler, a linking loader, and a 1750A simulator. Prices for the general-purpose LMC 1750A unit start at $60,000.

Develop on IBM PC/XT or PC/AT

If you already have an IBM PC/XT or PC/AT, you may not need to buy a complete 1750A system. Sabtech Industries, for example, offers a plug-in card, the PC-NTDS adapter, that interfaces the PC to the Naval Tactical Data Systems (NTDS) bus used by the AN/UYK-7, -14, -20, -43, and -44 naval tactical computers. The card provides a full 32-bit parallel connection to the MIL-STD-1397 NTDS bus; using the 16-bit data path of the PC/AT, it can transfer a 32-bit word in 1.2 μsec.

Approximately two-thirds of the circuitry on the board is related to the NTDS interface; the other one-third consists of an RS-422 serial port. By setting the 3-state line drivers of the RS-422 port to their high-impedance state, you can make the port transparent to other peripherals on the RS-422 bus; you can therefore program the PC to act as a bus monitor/analyzer. You can also program the PC to inject test stimuli into a peripheral or collect data from a peripheral during the execution of tactical software that you are testing. You can program the PC to simulate a tactical computer, a peripheral device, or a complete combat system. Simulation software comes with the board and includes source code for the NTDS drivers so that you can customize them for special applications. Two versions are available: The PC-NTDS for an IBM PC, PC/XT, or PC/AT costs $1600; the AT-NTDS, for the IBM PC/AT only, costs $2850.

The Mikros MKS1750/AT is a 1750A computer based on the company's MKS1750/M Multibus-compatible processor board. It contains a special card that interfaces to an IBM PC/XT or PC/AT. You can add other Multibus cards to provide extra memory or special peripheral interfaces. You write your software on the PC using standard USAF software tools (the ECSPO assembler and linker) that Mikros has modified to operate on the PC, and you then download the programs to the MKS1750/AT. You can test and debug your programs with the aid of the company's MMMON (Memory Management Monitor) software, which resides in the MKS1750/AT.



Bring us your printers,
your toasters,
your automotive control panels,
your control lines,
your microwave ovens…

for there are no more powerful
or cost-effective
microcontrollers available to run them
than the new Zilog Super8 family.*

Zilog The technology in your technology.

an affiliate of
EXXON Corporation

*And that may be an understatement. For complete information on all eight versions of the Z8 microcontroller from the ultra-sophisticated designer's delight, the **Super8**, comparable in performance to many 16-bit chips, to the ultra-inexpensive yet surprisingly powerful, plain vanilla plastic package **Z8**, call your nearest Zilog sales office or Zilog, Components Division, (408) 370-8022.

CIRCLE NO 59

A tracer card for tracing execution and setting hardware breakpoints is also available, and a MIL-STD-1553B interface card will be obtainable very soon. The MKS1750/AT costs $12,500, the tracer card $3475, and the 1553B interface card $6600.

Case tools encode

Computer-aided software engineering (CASE) tools allow you to code software on a VAX or an IBM PC and download the programs to the target system for test and debugging, and they provide additional help in the design phase and keep track of your changes during the maintenance phase (see **reference**). Of importance to designers of military equipment is the V1750A Integration Emulation System, a component of the CASE program from Tektronix Inc. This software/hardware tool not only allows you to develop your software on a VAX minicomputer, using structured analysis, but also provides a communications link for downloading the programs to an emulator.

The emulator allows you to run the programs at full speed and provides probe pathways to board edge connectors, in-circuit sockets, or test points on any MIL-STD-1750 target computer. The emulator lets you retain full control and monitoring capabilities during the testing of your programs; also, if a particular device is not available, the emulator can simulate it so that you can complete your project with the confidence that it will perform correctly when transferred to the full target system. The emulator costs $33,500.

EDN

Reference

Terry, Chris, "Programming aids minimize errors during software design, coding, and modification," *EDN*, April 17, 1986, pg 79.

Article Interest Quotient
(Circle One)
High 506 Medium 507 Low 508

For more information . . .

For more information on the ICs and development tools described in this article, contact the following manufacturers directly or circle the appropriate numbers on the Information Retrieval Service card.

Fairchild Camera & Instrument Corp
Microprocessor Div
450 National Ave
Mountain View, CA 94043
(415) 962-3888
Circle No 701

M/A-Com Linkabit Inc
3033 Science Park Rd
San Diego, CA 92121
(619) 457-2340
Circle No 702

McDonnell Douglas Astronautics Co
5301 Bolsa Ave
Huntington Beach, CA 92647
(714) 896-2329
Circle No 703

Mikros Systems Corp
3828 Quakerbridge Rd
Mercerville, NJ 08619
(609) 890-0440
Circle No 704

Performance Semiconductor Corp
610 E Weddell Dr
Sunnyvale, CA 94089
(408) 734-8200
Circle No 705

Sabtech Industries
4091 E La Palma Ave, Unit P
Anaheim, CA 92807
(714) 630-9335
Circle No 706

Tektronix Inc
Box 14752
Portland, OR 97214
(800) 342-5548
Circle No 707

Texas Instruments Inc
Box 22574
Dallas, TX 75265
(214) 480-1412
Circle No 708

DC/DC CONVERTERS
WHEN YOUR APPLICATIONS
DEMAND PERFORMANCE!

Meets requirements for
▸Airborne
▸Shipboard Electronic Systems
▸Military Ground Support Equipment

- Small size >10 watts/in.³
- High efficiency >80%
- High input/output isolation
- Fast response short circuit protection — automatic reset
- External shut-down control
- +5V @ 700mA from 28V DC line ±15V @ 250mA from 28V DC line
- Many built-in features help eliminate external parts/circuitry

intech
MICROCIRCUITS DIVISION
2270 Martin Avenue
Santa Clara, California 95050-2781
(408) 988-4930
CIRCLE NO 60

Standard equipment for those who don't use the Model 101 recorder.

You don't need to be lucky with the Honeywell Model 101 portable recorder.

The Model 101 is reliable. First and foremost. With features built for function, not fashion.

- Microprocessor-controlled auto test allows calibration verification at the speed *you* select
- Solid-ferrite heads warranted for 5,000 hours are so stable that the need to re-equalize is practically eliminated
- Vibration-isolated transport for reliable operation in mobile environments
- Average Mean Time Between Failure (MTBF) is 2,000+ hours
- Spare parts available overnight through a worldwide service network.

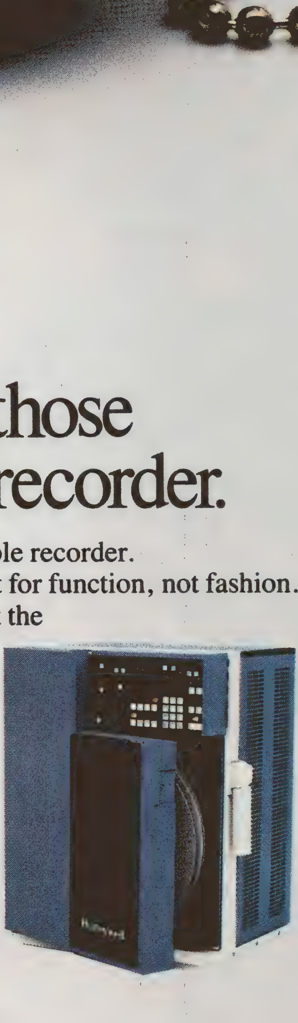
For details, contact Darrell Petersen, Honeywell Test Instruments Division, Box 5227, Denver, CO 80217-5227. (303) 773-4835.

Together, we can find the answers.

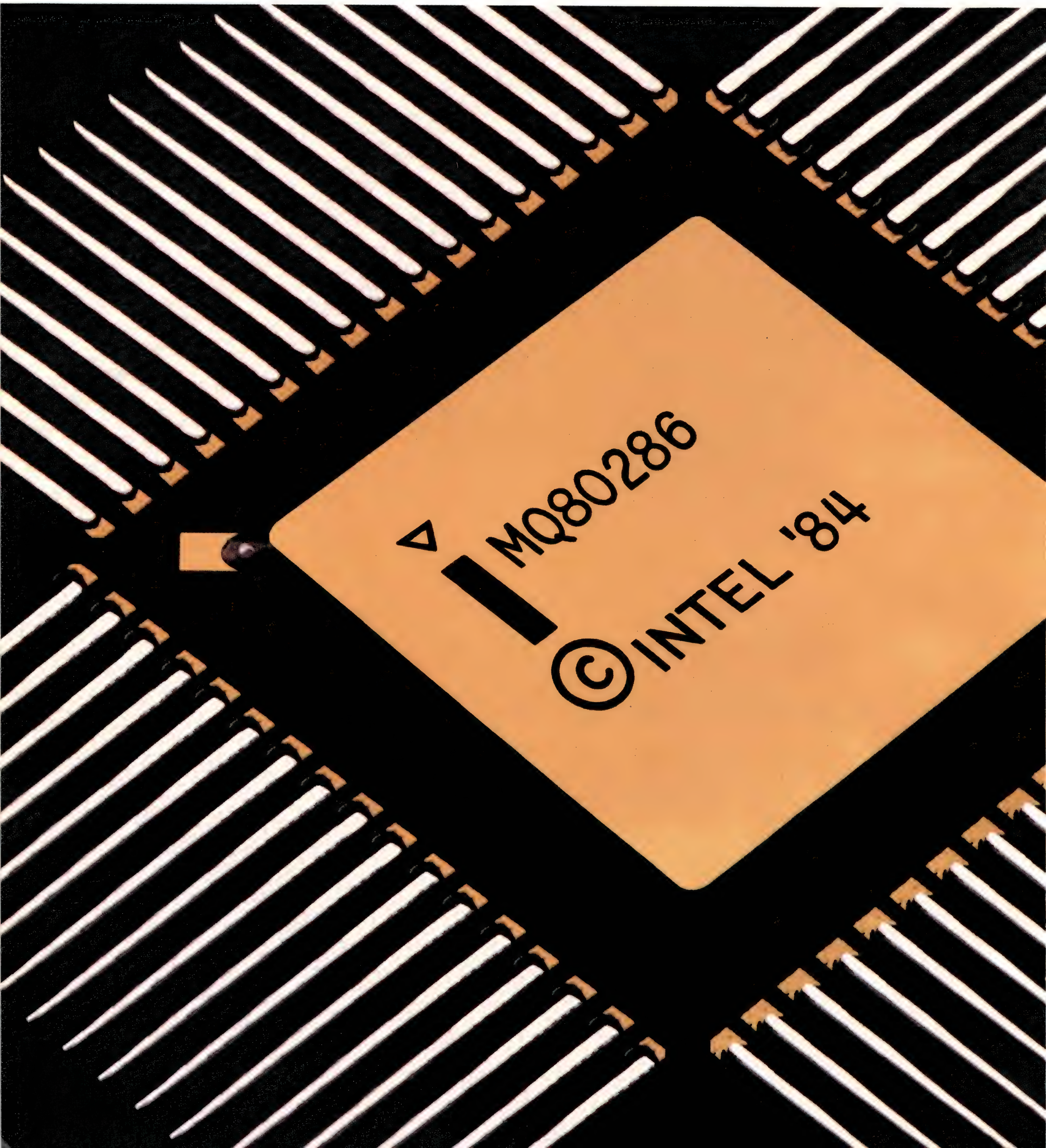
Honeywell

CIRCLE NO 61

©1986 Honeywell Test Instruments Division



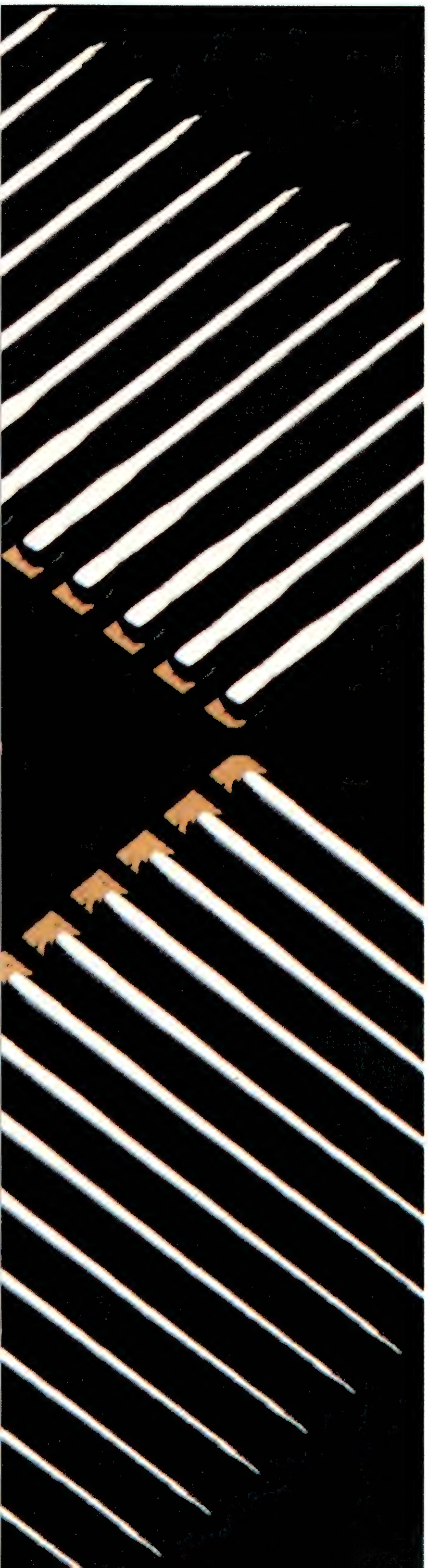
HOW TO RESPOND 978 MICROSECONDS FASTER THAN THE ENEMY.



It's only the blink of an eye. Not even that.

But an awful lot can happen in the blink of an eye these days.

And to get that crucial edge is very easy. Just see to it that the military grade microprocessor you design in has complete hardware support for multitasking built right into the chip.



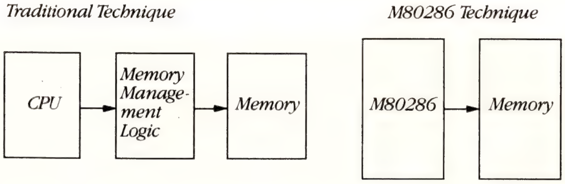
Ours does. So it's lots faster than trying to do task switching in software.

978 microseconds faster, to be exact.

Which means you can complete a full task switch in 22 microseconds flat (at 8 MHz). Instead of the millisecond it can take with a software solution.

98 percent more time for your system to respond. Giving you the advantage you need in an increasingly demanding tactical environment.

ACHIEVING PERFORMANCE MEMORY MANAGEMENT



M80286 integrated Context Switch, memory management and protection offers a fast, consistent, and highly portable multitasking solution.

And because our M80286 chip is based on Intel's high-performance M8086 microprocessor architecture, you are assured of the most powerful and easily upgradable engine available for military designs.

Included in the CPU is a memory management unit that equips the M80286 with hardware support for virtual memory and software protection. Making it ideal for military applications that require processing of massive amounts of information.

Performance is enhanced by exclusive pipelining features that eliminate delays in execution time. So the M80286 can do more instructions per clock than any other CPU.

System throughput can be further increased with our broad base of peripheral products. Such as our 80287 coprocessor and 82720 graphics controller. These chips are specifically designed to offload the numerics and graphics functions from the CPU.

In addition, the M80286 is optimized for higher level languages such as ADA. With ADA 286, designers can get greater systems flexibility and maximum performance.

And tomorrow? As your military system requirements grow, an upgrade path based on the same high performance architecture of our M80286 will be available with our 32-bit M80386 microprocessor.

For further information, call toll-free (800) 548-4725. Or write Intel Corporation, Lit. Dept. W281, 3065 Bowers Ave., Santa Clara, CA 95051.

We'll get back to you. Faster than you can blink an eye.

intel®

©1986 Intel Corporation

CIRCLE NO 62

Incorporating a touch activated display into your system shouldn't be an afterthought. Adding touch is the best way to make your product truly interactive, easier to use, and better suited for the real world.

It's no wonder that touch is growing in popularity. And used in a wide range of applications—from interactive video displays in stores, banks, airports, and hotels to specialized systems in hospitals, training facilities, and factories.

But it's important to add the right touch. That's why Carroll Touch developed the Smart-Frame™ line of low-cost scanning infrared touch systems. Featuring a powerful, built-in microcomputer, these add-in units provide exceptional functionality and reliability at the right price. Just the right touch for a great design.

Discover more about Smart-Frame products. Contact Carroll Touch today.

Start with the right touch.
Finish with a great design.

Carroll Touch
a subsidiary of **AMP** Incorporated

In Touch with Technology

P.O. Box 1309
Round Rock, TX 78680
512/244-3500, Telex 881906

Carroll Touch and Smart-Frame are trademarks of Carroll Touch, Inc.

CIRCLE NO 63

We run with a great crowd.

Complete hardware/software compatibility.

Talk about easy interfacing. You can take a ZETA 824 or ZETA 836 plotter and plug it into virtually any computer made.

What's more, you'll be ready to run because our plotters understand a variety of computer protocols. Select the model for your application then just plug in and plot.

In fact, we're a plug compatible replacement for many plotters from HP, CalComp and Tektronix. Some models of our plotter can even run directly from your IBM cluster controller. Now that's easy interfacing.

When it comes to your favorite application packages, you'll be on safe ground too. Packages such as CADAM, TechniCAD, Euclid, P-CAD, AutoCAD and many more.

The most productive plotter for the money.

You'll be getting the highest output plotters for the money with our new ZETA 824CS and ZETA 836CS. More finished plots. More productivity. Plus, these "D" and "E" format plotters let you run either single sheet or roll media.

Easy-to-use touch controls.

Your time is valuable. So we've made our touch controls simple – yet powerful. Set speed, pen pressure, liquid ink parameters, electronic limit sensing, windowing, scaling – all at the touch of a finger, Self-test and diagnostic plots too. Let us show you dozens of other time-saving operations in a brief demonstration.

Plotter specialists.

We've been designing hardware interfaces, plotting language emulators and high performance pen plotters for over 14 years. Nicolet also provides you with worldwide sales and service support.

Give us a call. See how easy it is to join the crowd.

Call (415) 372-7568.
Nicolet Computer Graphics
Division, 777 Arnold Drive,
Martinez, CA 94553
TWX 910-481-5951

Nicolet
Computer Graphics Division

CADAM is a trademark of CADAM, Inc.
TechniCAD is a trademark of Tektronix, Inc.
Euclid is a trademark of MATRA DATAVISION, Inc.
P-CAD is a trademark of Personal CAD Systems.
AutoCAD is a trademark of Autodesk, Inc.

CIRCLE NO 64

Mil spec Multibus*, Intel compatible and CMOS!

All these features now available in one mil spec computer product: Plessey Microsystems PMM 86.

Realise the full benefits of CMOS: power requirements reduced by as much as 75%, smaller and lighter packaging, and no compromise in performance.

All these and the traditional PMM 86 benefits add up to the military and severe environment product range for now and the future.

PMM 86 has inherent multiprocessor capability with 16-bit 8086 and 80286 processors and their arithmetic coprocessor counterparts. All PMM 86 systems have comprehensive built-in test (BITE) and still maintain full Intel Multibus SBC compatibility.

Plessey offers support for the iRMX 86 operating system giving both a run-time and a software development environment. ADA products from major vendors have been targeted to PMM 86.

Contact your nearest Plessey Microsystems office.

PLESSEY

USA: One Blue Hill Plaza, Pearl River, New York 10965.
Telephone: (914) 735 4661. TWX: 710 541 1512.
France: BP 74. 7-9 rue Denis Papin, 78194 Trappes.
Telephone: (1) 30.51.49.52. Telex: 696441.
Germany: D-6090 Rüsselsheim, Bahnhofstraße 38.
Telephone: (061 42) 680 04. Telex: 1761 4293.
United Kingdom: Water Lane, Towcester, Northants. NN12 7JN.
Telephone: (0327) 50312. Telex: 31628.

**Intel trademark* *PLESSEY and the Plessey symbol are trade marks of The Plessey Company plc.*

CIRCLE NO 65

Frame-grabber system for MicroVAX II provides 512×512×8-bit image processing

The DT2651 video frame-grabber board is a single-board, image-processing product that works with DEC's MicroVAX II, Micro/PDP-11, and LSI-11 systems. According to its manufacturer, the board is the only single-board system that can perform real-time math and logic operations on single or multiple 512×512-bit images with full 8-bit (256 gray levels) accuracy.

An additional board, the DT2658 auxiliary frame processor, works in conjuction with the DT2651 (**Fig 1**). The DT2658 is a pipelined processor that connects directly to the DT2651 over dedicated I/O ports to speed the completion of lengthy image-processing calculations. In this tandem configuration, the frame processor can perform a 3×3 convolution on a 512×512×16-bit image frame in 0.85 sec, or 25 times faster than the processor in the MicroVAX II.

Multiple synchronization inputs and outputs on the DT2651 frame grabber allow the board to operate from both standard and nonstandard video sources, including video cameras, VCRs, and slow-scan devices. The board digitizes all input signals into 512 horizontal lines, each containing 512 pixels. Each pixel has an 8-bit numerical value that corresponds to one of 256 possible gray levels.

A software-selectable multiplexer on the DT2651 allows the board to capture images from as many as four cameras. Essential to the frame grabber's performance is its onboard, 8-bit, 100-nsec/pixel arithmetic logic unit, which is incorporated into a look-up-table processor. This processor provides a feedback path that allows complete 512×512×8-bit images stored in either of the two frame-store memory buffers to pass back through the 8-bit ALU and back through the 512×8-bit look-up tables. This feedback process provides for processing stored and acquired images in real time, with full 8-bit accuracy.

Typical DT2651 image-processing functions include merging, subtracting, and offsetting image frames; the board can also multiply or divide images by a constant. The ALU

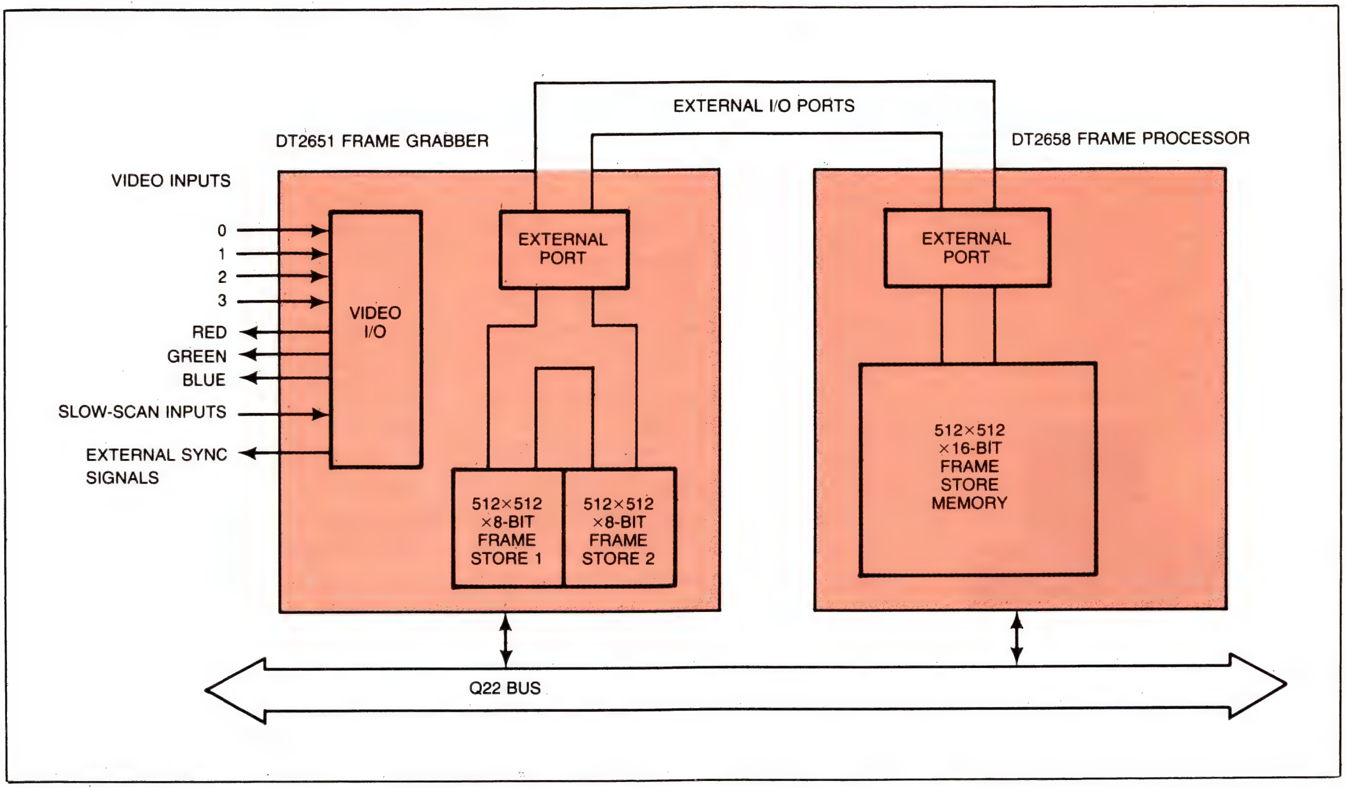
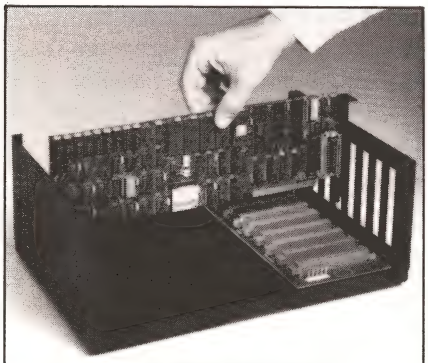


***Fig 1—Avoiding the Q22 bus pathway** speeds the operation of the DT2651 frame grabber and the DT2658 auxiliary frame processor. The processor boards connect directly to each other over separate I/O ports, so entire image frames can transfer between the two boards at high speeds.*

The PC Bus:

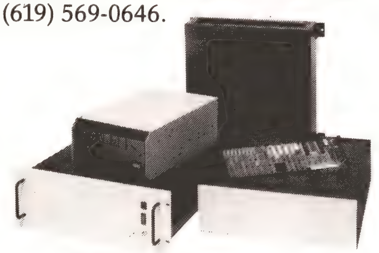
Cost-Effective, Board-Level Solution To System Integration



Get your dedicated system to market *months* sooner with the PC Bus. Full board-level implementation by I-Bus lets you plug together system components from hundreds of PC Bus board manufacturers, and directly execute software developed on and for the IBM® PC.

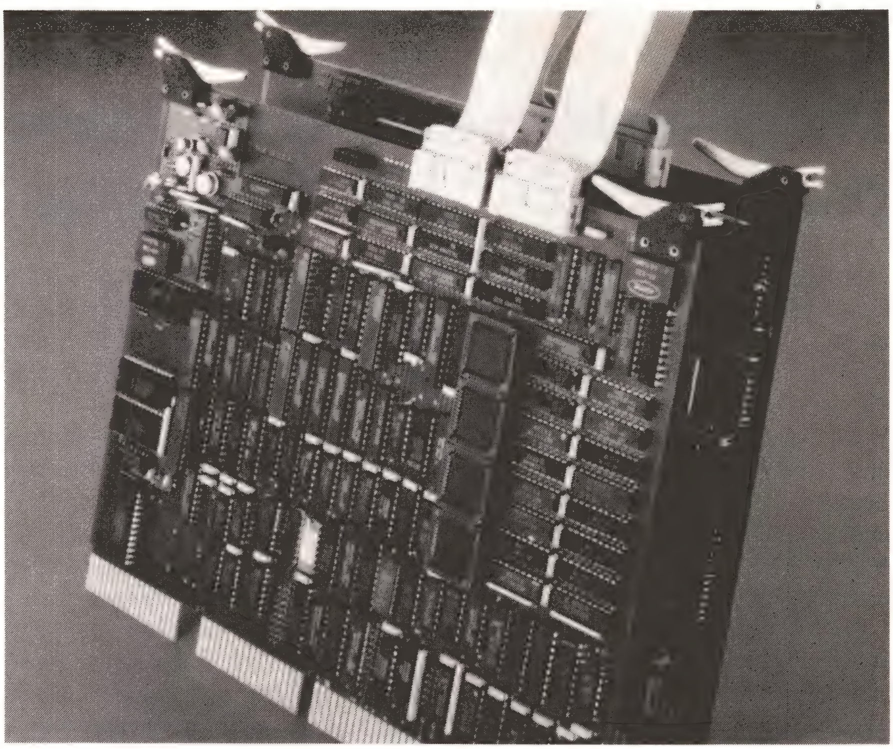
I-Bus has board-level CPU's with 8088 or 80188 processors, full disk or diskless operation and up to 160K of EPROM, 256K of RAM on board. We have the most complete line of system packaging for the PC Bus, too.

Start cutting your schedule today—give us a call today at (800) 382-4229. In California, call (619) 569-0646.



I-BUS
SYSTEMS
9235 Chesapeake Drive
San Diego, CA 92123

CIRCLE NO 66



A single-board image processor for 512×512×8-bit images, *Model DT2651 works with DEC's MicroVAX II, PDP-11, and LSI-11 computers. In conjunction with the DT2658 auxiliary frame processor, the board performs real-time math and logic operations on images and provides 8-bit accuracy. Such real-time performance previously required three to six processing boards, totaling $10,000 to $15,000.*

provides 48 arithmetic and logic operations. Like other multiboard image processors, the DT2651 offers multiple-input and -output lookup tables for creating thresholds and contours and for providing RGB false color.

Two 256k-byte memory buffers on the DT2651 frame grabber provide storage for two complete image frames; this double-buffered architecture permits parallel processing of multiple images. The system can transfer images captured in one memory buffer to the DT2658 auxiliary frame processor for convolution or histogram construction at the same time other images are averaged, offset, or overlaid with graphics—in real time—in the other buffer.

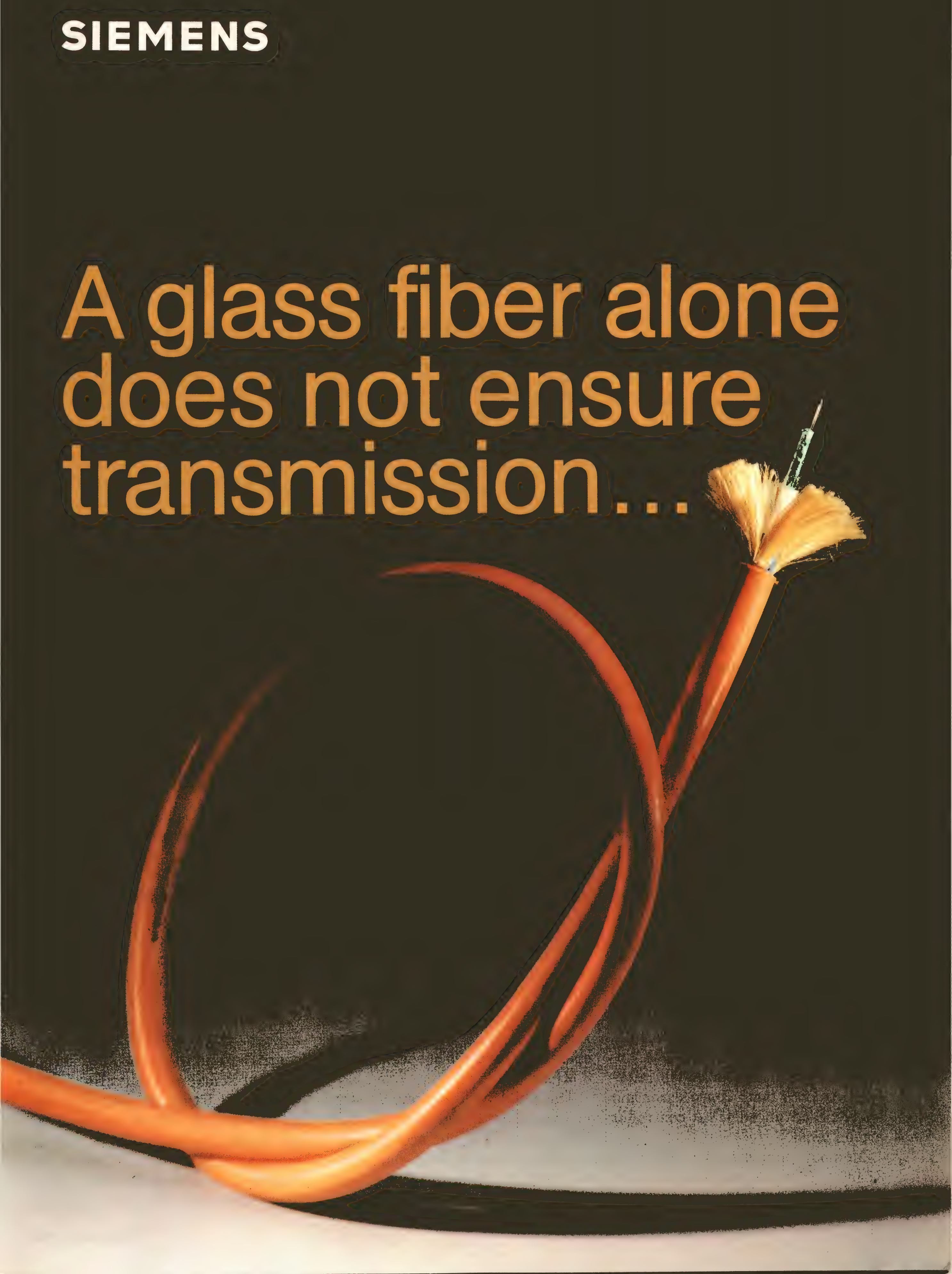
Model DT2658 is a 16-bit, pipelined processor that accelerates arithmetic-intensive image-processing operations. For example, the board executes user-defined N×M convolutions (an operation popularly used for edge detection and edge enhancement of objects) at near-real-time speeds.

The two principal arithmetic-processing elements on the DT2658 auxiliary processor are a RAM conversion table and a 16-bit ALU. In addition to N×M convolutions, the conversion table and ALU operations provide for 256-bin histograms, zoom, pan, scroll, and numerous arithmetic and logic operations. For all calculations, 16-bit/pixel internal accuracy eliminates round-off errors in intermediate calculations.

To avoid the possibility of being bogged down by the host bus, the DT2651 and DT2658 connect to each other over external I/O ports. Separate from the Q22 bus, these ports permit the high-speed transfer of entire image frames. DT2651, $2995; DT2658, $1595.—***Bill Travis***

Data Translation Inc, 100 Locke Dr, Marlboro, MA 01752. Phone (617) 481-3700. TLX 951646.

Circle No 729


SIEMENS
A glass fiber alone does not ensure transmission...

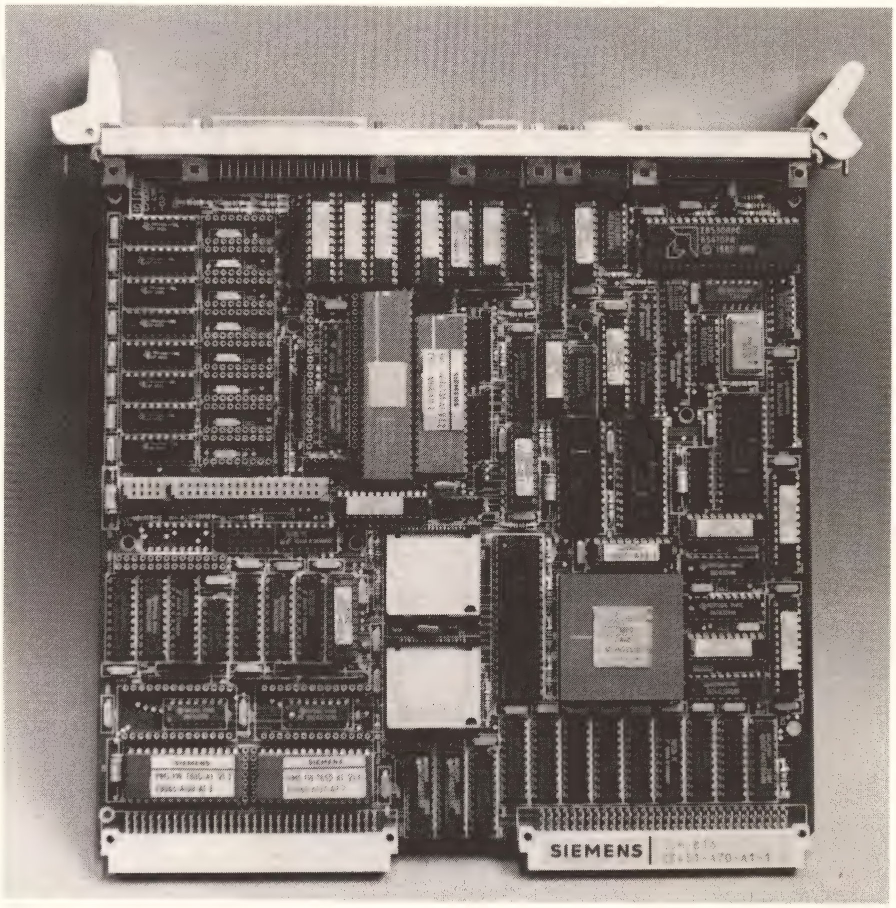
Multibus II board family works with Eurocard-based subsystem buses

The OSM-B family includes a Multibus II-compatible CPU, memory, and serial-interface cards, thus providing all the components necessary to implement a high-performance 16- or 32-bit computing nucleus. In addition, a central-services board, which provides system-level Multibus II functions, also includes an interface to the 16-bit AMS Bus—an implementation of the Multibus I electrical specification on double Eurocards—thus allowing you to add intelligent I/O to the Multibus II system.

The OSM-B26 CPU card features an 8-MHz 80286 μP combined with an 82258 advanced DMA controller and an optional 80287 math coprocessor. The board has two 28-pin JEDEC memory sockets; an LBX II bus interface provides local-memory extension. Support is provided for 16 levels of message-based vectored interrupts with as many as 255 distinct interrupt sources or destinations. The board has two RS-232C serial interfaces, one of which you can configure to be RS-422A compatible, and a 24-line parallel port, which you can configure as a SCSI, Centronics, or general-purpose I/O port. An onboard interface connector allows you to add SBX-compatible piggyback I/O modules.

The OSM-B16 is an 8-MHz, 80186-based single-board computer with as much as 512k bytes of dual-port onboard dynamic RAM, four 28-pin EPROM/static-RAM sockets, a parallel interface, an RS-232C interface, and an RS-422A/449 interface. An 8087 math coprocessor and an 82258 advanced DMA controller are optional.

Memory support for 16- and 32-bit CPUs is provided by the 32-bit OSM-B11x Series dynamic-RAM boards, which range in capacity from 512k bytes to 4M bytes. The memory is dual-ported to the Multibus II PSB and LBX II buses, and the boards feature an 8k-byte cache, which provides zero-wait-state cache-hit access via the LBX II bus. Access for cache misses and write operations involves one wait state at 8 MHz.



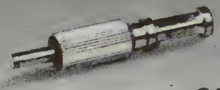
CPU, memory, communications, and central-services computer boards *allow you to build a Multibus II computing nucleus with links to Eurocard-based intelligent I/O subsystem-bus systems.*

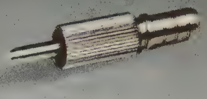
The OSM-B130 universal memory-expansion board also supports PSB or LBX II bus access, and it provides you with 16 28-pin sockets for EPROM, ROM, EEPROM, static-RAM, or nonvolatile-RAM devices. It also supports dynamic configuration of the memory and diagnostics through the Multibus II interconnect space and furnishes battery backup of the memory when the system power fails.

Available communications boards include the OSM-B223 Ethernet controller and the OSM-B222 serial-communications controller. The OSM-B223 Ethernet controller has an onboard 80186 μP, as much as 1M bytes of dynamic RAM, and as much as 512k bytes of EPROM, allowing it to support an ISO transport- and network-layer communi-

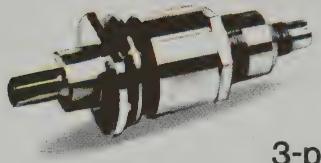
... because only the fiber optic components from Siemens make for perfect communication.

All you need
for a simple point-to-point connection
is a transmitter and a receiver.





And the proper
connectors to connect the optical waveguide.



But we offer you also components for more
complex transmission systems.

For example,
3-port couplers and star couplers
for up to 64 ports
for the separation and mixing of
optical signals.

Or relays,
(optical
switches)
for the
switchover of optical transmission channels.

Using multiplexers
you can simul-
taneously transmit,
over one
glass fiber, two or more optical signals
of different wavelength.

Your advantage: No problems with the
compatibility of components.
Because we keep a complete range
of products in stock.

CIRCLE NO 67

To: Siemens AG, Infoservice 143/1069, Postfach 2348, D-8510 Fürth.
☐ Yes, I would like to know more about your products.
Please send me further information free of charge.
Name
Street
Postal code
Place
A19100-N63-Z2-7600
EDN62686

Keep Time

Keeping track of human time hasn't been easy for computer systems. Until now.

The SmartWatch DS1216 and DS1216E from Dallas Semiconductor reports the hour, day, month and year, down to the one hundredth of a second. With the SmartWatch any system can tell time.

A CMOS timekeeping circuit is embedded in a JEDEC Bytewide 28 pin DIP socket that accepts a RAM or EPROM. This design saves space and components compared to other I/O intensive approaches.

The SmartWatch has some rather startling side benefits. The DS1216 circuitry and self-contained lithium energy source do more than maintain calendar time. The data of a CMOS RAM mated with the socket is preserved for more than 10 years. Wherever a EPROM is used, the DS1216E retrofits perfectly. The address space of the mated RAM or EPROM is left undisturbed because time information is made available through a phantom interface on software demand.

SmartWatch: A design whose time has come. Call us now for more information

DALLAS SEMICONDUCTOR

(214) 450-0400
Distributors: AVED, Advent, Almac, Hall-Mark, Insight, Milgray, Quality, Western Micro, Future

CIRCLE NO 68

cations-software package. The OSM-B222 serial-communications board has six communications channels, expandable to 10. Four channels support RS-232C; you can configure the remaining two channels to support RS-232C or RS-422A/-449 interfaces. It features an onboard 80186 μP, as much as 512k bytes of dynamic RAM, and four 28-pin JEDEC memory sockets. An 82258 DMA controller provides high-speed data transfers. The board also has two SBX connectors for I/O expansion.

The OSM-B500 central-services module provides the central system functions of clock, reset, and timeout error generation, plus slot identification and arbitration identification initialization. The board also provides a time-of-day clock and an AMS Bus interface, which allows you to add the company's current range of double Eurocard 16-bit AMS Bus boards and (via an AMS Bus card) its 8/16-bit single Eurocard SMP Bus computer boards.

Additional boards planned for introduction during the third quarter include an 80386-based CPU card and accompanying memory cards, as well as a mass-storage interface card.

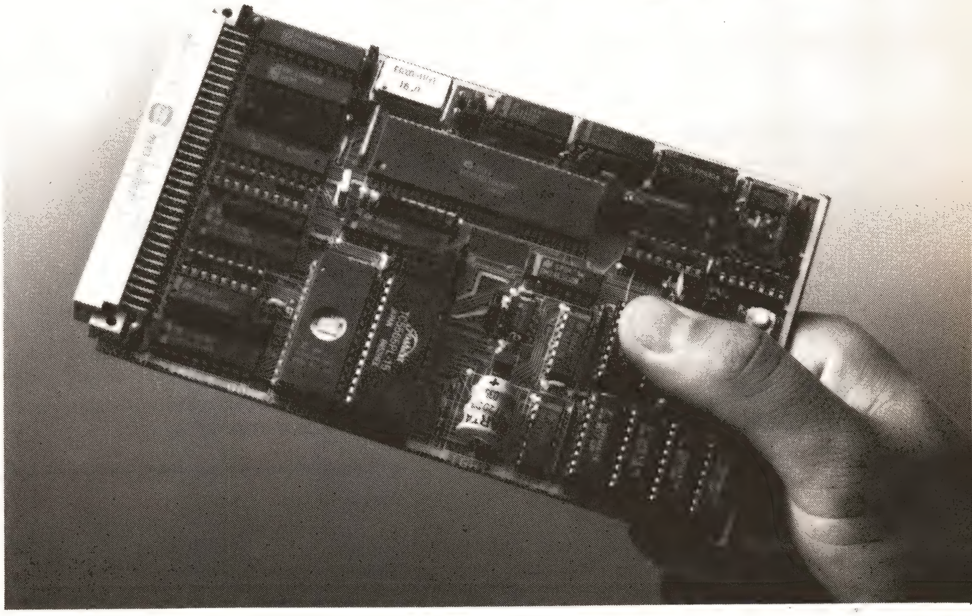
Prices for the OSM-B Series boards are as follows: OSM-B26, DM 7320; OSM-B16, DM 5500; OSM-B111 (1M byte), DM7325; OSM-B130, DM 4200; OSM-B223, DM 6000; OSM-B222, DM 6000; OSM-B500, DM 2700.

—Peter Harold

Siemens AG, Zentralstelle für Information, Postfach 103, 8000 Munich 1, West Germany. Phone (089) 2340. TLX 5210025.

Circle No 725

The STE Bus is in high gear.



If you're becoming aware that your bus has some shortcomings where real world interfacing needs to be done, look at the STE Bus. It's processor-independent, and it stands alone or works as a VME expansion bus.

Single Height Eurocard: the best board-level construction, with reliable DIN connectors and a size (3U) that's ideal for I/O.

More Performance, More Economy: there's much less bus interface "overhead" on each card, compared to VME or Multibus, so you can economically adapt your I/O card requirements to your real I/O needs. Yet you need not sacrifice features like speed, DMA and multilevel interrupt capability, compared to the Motorola VME I/O Channel*.

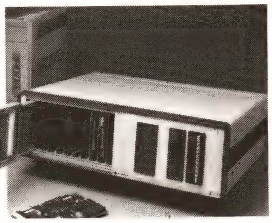
Standardized: IEEE Working Group P1000.

VME Compatible: use the STE Bus as a VME I/O Channel with one of PII's Couplers or Protocol Converters. Map an entire STE subsystem right into your VME bus system.

Complete: choose from a huge list of STE boards for every application—available now from PII. Call us today for all the details.

Over 50 STE boards now available from PII!

CPU cards:
68008, 6809, 64180, 80188 and Z80A
Memory Cards:
64K to 1MB DRAM, 256K byte wide, and CMOS RAM/clock/battery
Peripheral Control Cards:
Hard/Floppy Controllers, SASI, SCSI, HD63484 ACTRC Graphics, System control/watchdog
Communications I/O Cards:
RS-232,422,423, IEEE-488
Digital & Analog I/O Cards:
32,40 line digital; 2,4,8,16,32-channel analog I/O, thermocouples, 4-20mA, opto, SS relays, etc.
Plus . . . . Development Systems (shown here), VME/STE Couplers, backplanes, prototyping cards



Performance Interconnect, Inc.
10052 Mesa Ridge Ct., San Diego, CA 92121 • (619) 457-0665
Telex: 650-289-2924
ANS: 289-2924MCI

***Quick comparison STE Bus vs. Motorola I/O Channel**

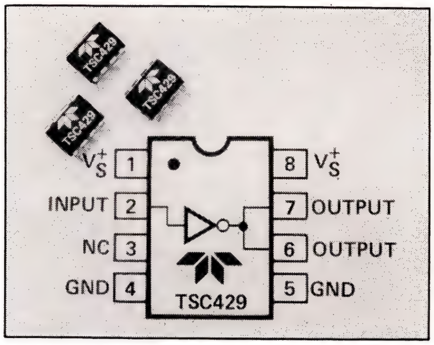
	Transfer Speed (bytes/sec)	Number of Interrupts	Multiproc Support	DMA Support
STE Bus	5M	8	Yes	Yes
Motorola I/O	2M	4	No	No

CIRCLE NO 69

CMOS-processed power-MOSFET driver IC boosts CMOS or TTL levels to 18V, 6A

A CMOS IC designed to drive power MOSFETs simplifies the drive circuitry for very large MOSFETs. The TSC429 driver can translate a low-power CMOS or TTL input to an output that swings from 0 to 18V and supplies peak currents as high as 6A. **Fig 1** shows a typical application for the driver IC.

By rapidly charging and discharging a MOSFET's static and Miller-effect gate capacitance, the device minimizes the switching losses in the MOSFET. The TSC429 can produce an 18V swing in a 2500-pF load in 25 nsec. Increasing the load to 10,000 pF increases the rise time to about 80 nsec. Note that the ability to drive capacitive loads is important because power MOSFETs have static gate capacitance as high as 6000 pF.



***Cut switching losses in power MOSFETs** by using the TSC429 MOSFET driver. The CMOS IC provides plenty of driver to even the most capacitive of loads.*

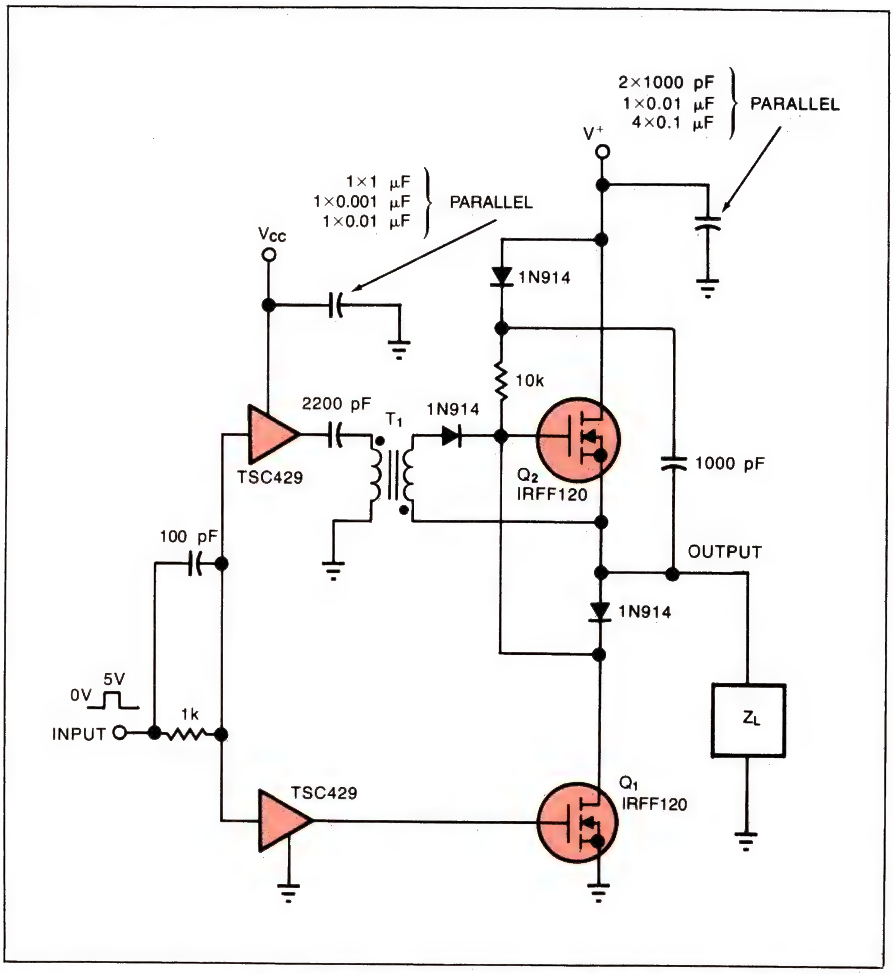


*Fig 1—**Providing drive to a quasi-complementary power-MOSFET switching amplifier,** the TSC429 rapidly charges and discharges the FETs' input capacitance. In this circuit, the transformer provides inversion for the output of the TSC429 driving the upper MOSFET.*

Output impedance of the TSC429 is 2.5Ω max, and delay time through the device is 75 nsec max. The rise and fall times (35 nsec max for a 2500-pF load) and positive- and negative-going delays (75 nsec max) are closely matched.

The TSC429 operates from one 7 to 18V supply; the device provides output swings between 25 mV of ground and the positive supply, thereby ensuring that the power MOSFET turns fully on or off. The TTL- and CMOS-compatible inputs draw only 10 μA and provide about 300 mV of hysteresis, which ensures fast output switching and freedom from oscillation in the presence of slow-rising input signals. The input-voltage range extends as high as the power-supply voltage.

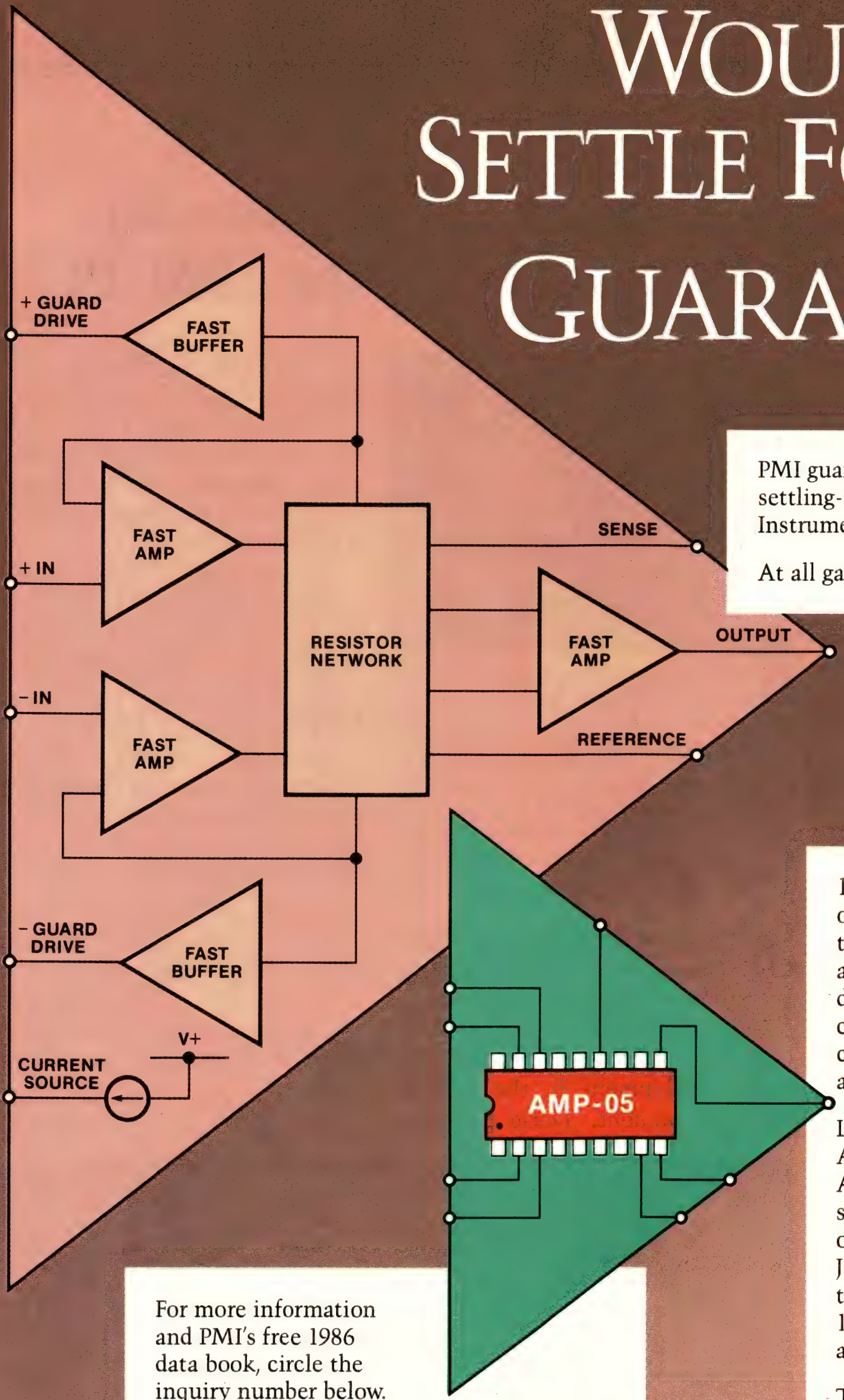
Although the TSC429 can supply very high peak drive currents to a power MOSFET, the device draws only 5-mA max quiescent current from its supply. When the IC drives a 2500-pF load from a 15V supply at 100 kHz, the current drain is less than 10 mA. Housed in an 8-pin plastic (commercial range) or hermetic (industrial or military range) DIP, commercial-, industrial-, and military-range units cost $1.95, $3.50, and $10 (100), respectively.

— Bill Travis

Teledyne Semiconductor, 1300 Terra Bella Ave, Mountain View, CA 94039. Phone (415) 968-9241.

Circle No 726

WOULD YOU SETTLE FOR 15μs? GUARANTEED?



PMI guarantees 12-bit settling-time for its AMP-05 Instrumentation Amplifier.

At all gains.

15μs settling-time and 15μs overload recovery time set the stage for high-speed data acquisition. On-board guard drivers and a 100μA precision current source minimize components, save board space, and increase versatility.

Like PMI's industry standard AMP-01, the monolithic AMP-05 provides a high and stable common-mode rejection of 105dB MIN. over temperature. JFET inputs reduce bias currents to 50pA MAX. (20nA MAX. at 125°C), for high impedance applications.

The AMP-05's output is guaranteed stable with 2nF loads, slews at 5V/μs, and has a gain-bandwidth product of 120MHz.

For more information and PMI's free 1986 data book, circle the inquiry number below.

Precision Monolithics Inc.
A Bourns Company
1500 Space Park Drive
Santa Clara, CA
95054-3499
(408) 727-9222

1-800-843-1515
or, in California
1-800-826-9664

FRANCE: 01-42 03 96 33, GERMANY: 0711-22 93 0, NETHERLANDS: 070 87 54 04, SWITZERLAND: 042-33 33 33, UNITED KINGDOM: 01-572 65 31, HONG KONG: 0-4992688, JAPAN: (03) 234-1411, ARGENTINA: 46-5776/0628/0864/2214, AUSTRALIA: (02) 570-8122, AUSTRIA: 0222-43 26 39, DENMARK: 02-98 63 33, EASTERN EUROPE: 0222-24 71 37, FINLAND: 90-75 06 00, GREECE: 01-821 58 25, INDIA: 222-999, ISRAEL: 03-49 44 50, ITALY: 02-569 57 46, KOREA: (02) 244-7492, NORWAY: 02-83 02 20, PORTUGAL: 19-68 60 72, SINGAPORE: 747-6188, SOUTH AFRICA: 52 86 61 OR 011-839 18 24, SPAIN: 01-405 42 13, SWEDEN: 08-768 05 60, TURKEY: 041-30 15 10, YUGOSLAVIA: 041-42 37 46.

® PMI

The precision solution.

CIRCLE NO 70

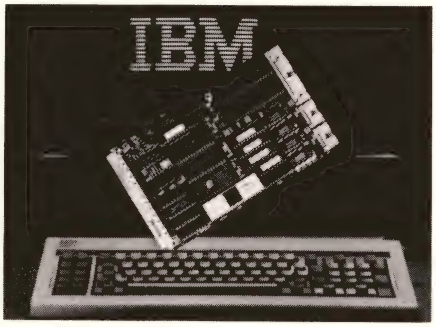
Hardware/software package lets you develop software for G64 Bus boards on the IBM PC

A hardware/software package for the IBM PC and compatibles lets you develop software for Intel 8088/8086-based G64 Bus products on your PC and debug the software on the target hardware. The Genescope and Access software packages from Genesis Microsystems operate with the Gespac GESSBS-5 single-board computer, which is compatible with the standard G64 Bus.

The GESSBS-5 8088-based CPU board has three JEDEC sockets, which let you configure the board with as much as 64k bytes of RAM, 64k bytes of EPROM, or 16k bytes of nonvolatile EEPROM (or a mixture of the three). Two 8256 peripheral chips provide the board with 20 bits of parallel I/O, two serial ports, and 10 programmable timers. The board can stand alone or can function as the CPU in a multiple-board system. This quarter, Genesis Microsystems will port Access to the GESSBS-8 8088-based board and the 80286-based GESMPU-18.

To perform the software development, you first edit, compile, and assemble code on your IBM PC. You can use the Genelink linker from Genesis to link code developed in a modular fashion. You then use the Access program to download object code via a 19.2k-baud serial link to the target GESSBS-5 board. Once the code is downloaded, you can execute and debug your program on the target hardware.

For debugging on the target board, you can use Genesis's Genescope screen-oriented debugger, which operates as a text editor does. It displays symbol names and line numbers from source code instead of from the hexadecimal address and data. The debugger also features breakpoint-setting, single-step, block-move, pattern-finding, and symbol-handling commands.



You can save time and money *by developing software for Intel 8088/8086-based G64 Bus products on your PC and debugging the software on the target hardware. This hardware/software development package, which consists of the GESSBS-5 single-board computer from Gespac and the Genescope and Access programs from Genesis Microsystems, runs on IBM PC and compatible computers.*

Genesis offers a number of Intel's UDI-based 8086 packages for software development in the Access/G64 environment. These packages include PL/M 86, Fortran, Pascal, MWC86, ASM 86, and object-code management utilities. The Access/G64 environment is also compatible with Microsoft's macroassembler and Lattice's C compiler, as well as other software.

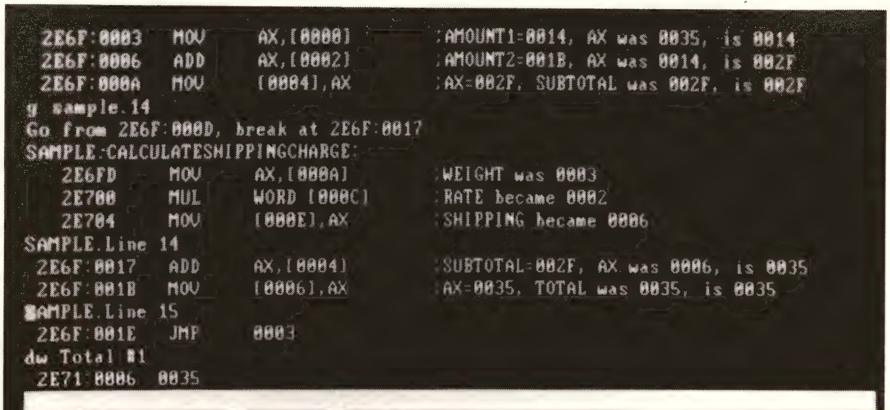
Gespac and Genesis Microsystems both offer these and other languages and utilities for 8088/8086 development. The GESSBS-5 target board costs $595; the Genescope EPROM kit costs $1495. Both are available from Gespac. The Genelink linker, which is available from both companies, costs $495. The Access software package also sells for $495.—***Maury Wright***

Genesis Microsystems Corp, 196 Castro St, Mountain View, CA 94041. Phone (415) 964-9001.

Circle No 723

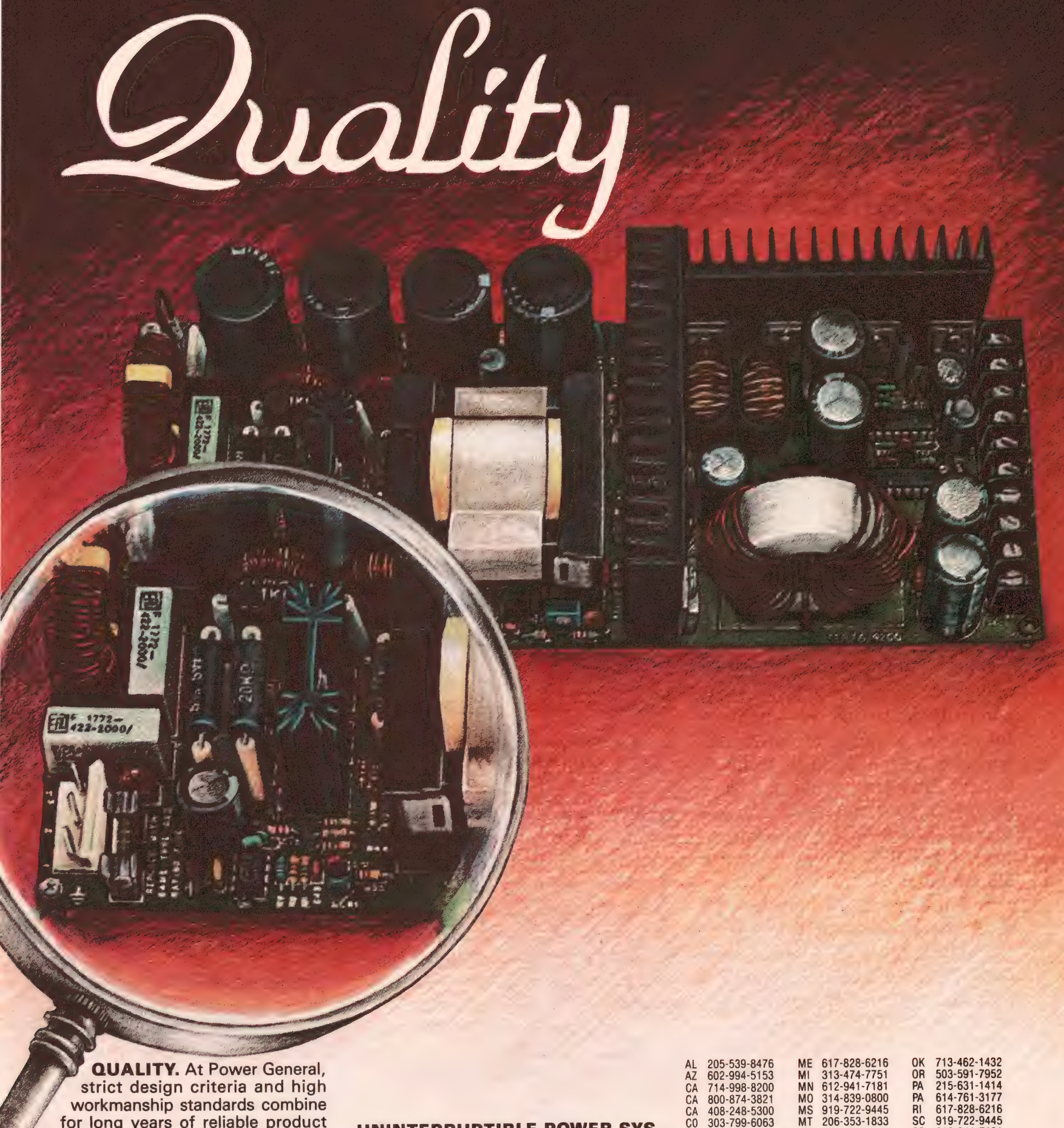
Gespac Inc, 100 W Hoover Ave, Mesa, AZ 85202. Phone (602) 962-5559.

Circle No 724



```
 2E6F:0003   MOV     AX,[0000]          ;AMOUNT1=0014, AX was 0035, is 0014
 2E6F:0006   ADD     AX,[0002]          ;AMOUNT2=001B, AX was 0014, is 002F
 2E6F:000A   MOV     [0004],AX          ;AX=002F, SUBTOTAL was 002F, is 002F
g sample.14
Go from 2E6F:000D, break at 2E6F:0017
SAMPLE.CALCULATESHIPPINGCHARGE:
   2E6FD     MOV     AX,[000A]          ;WEIGHT was 0003
   2E700     MUL     WORD [000C]        ;RATE became 0002
   2E704     MOV     [000E],AX          ;SHIPPING became 0006
SAMPLE.Line 14
 2E6F:0017   ADD     AX,[0004]          ;SUBTOTAL=002F, AX was 0006, is 0035
 2E6F:001B   MOV     [0006],AX          ;AX=0035, TOTAL was 0035, is 0035
SAMPLE.Line 15
 2E6F:001E   JMP     0003
dw Total #1
 2E71:0006  0035

AX=0035 BX=0000 CX=0000 DX=0000 BP=0064 SI=0000 DI=0000
DS=2E71 ES=2E65 SS:SP=2E68:0064 CS:IP=2E6F:0003 FL=F216
SAMPLE.Line 12
 2E6F:0003 A10000          MOV     AX,[0000]          ;AMOUNT1
 2E6F:0006 03060200        ADD     AX,[0002]          ;AMOUNT2
 2E6F:000A A30400          MOV     [0004],AX          ;SUBTOTAL
SAMPLE.CALCULATESHIPPINGCHARGE
 2E6F:000D A10A00          MOV     AX,[000A]          ;WEIGHT
```

This EPROM-based symbolic debugger, *Genescope from Genesis Microsystems, allows you to debug programs in a high-level environment on a target GESSBC-5 G-64-bus board.*



QUALITY. At Power General, strict design criteria and high workmanship standards combine for long years of reliable product operation. High quality products, all backed by a standard two (2) year warranty.

SWITCHING POWER SUPPLIES – The world's smallest, 1 to 5 outputs over a range of 25 to 200W. Features include UL, CSA, and VDE approval, input line filters, selectable inputs, and high efficiency operation.

DC-DC CONVERTERS – A full line of encapsulated and open board power converters featuring 1 to 60W, single, dual or triple outputs, high input/output isolation, 2:1 input voltage range, high efficiency, and remote on/off.

UNINTERRUPTIBLE POWER SYSTEMS – 200W and 400W models provide reliable back-up power to computer based equipment in the event of power failure. Features include 1.5mS transfer time, audible/ visual alarms, internal battery and desk-top styling.

Long reliable operation at high performance levels; Power General delivers the total solution to your power requirements. Products that fit your needs.

For complete technical data contact your nearest **POWER GENERAL** *sales office or call our Instant Literature Line: 617-828-6216 Ext 322*

CIRCLE NO 71

AL	205-539-8476	ME	617-828-6216	OK	713-462-1432
AZ	602-994-5153	MI	313-474-7751	OR	503-591-7952
CA	714-998-8200	MN	612-941-7181	PA	215-631-1414
CA	800-874-3821	MO	314-839-0800	PA	614-761-3177
CA	408-248-5300	MS	919-722-9445	RI	617-828-6216
CO	303-799-6063	MT	206-353-1833	SC	919-722-9445
CT	203-248-4380	NC	919-722-9445	SD	612-941-7181
DE	800-336-3747	ND	612-941-7181	TN	919-722-9445
FL	305-977-0331	NE	314-839-0800	TX	214-437-4833
FL	305-425-6149	NH	617-828-6216	TX	713-462-1432
GA	919-722-9445	NJ	201-340-1515	TX	512-459-0802
IA	319-365-8071	NM	602-994-5153	UT	801-546-4029
ID	206-353-1833	NV	702-329-9440	VA	703-478-2480
IL	312-991-2144	NY	315-662-7996	VA	804-239-8486
IN	614-761-3177	NY	518-371-6864	VT	617-828-6216
KS	816-229-4007	NY	607-756-6592	WA	206-353-1833
KY	614-761-3177	NY	716-223-1030	WI	312-991-2144
MA	617-828-6216	OH	614-761-3177	WV	614-761-3177
MD	800-336-3747	OK	214-437-4833		

POWER GENERAL

A SUBSIDIARY OF **UNITRODE** CORPORATION

Development system configures filter IC for application-specific analog response

Even if you are inexperienced in the intricacies of analog-filter design, you can exploit the features of the ICE (in-circuit emulator) filter-development system, an interactive design tool that gives you the capability to synthesize filter functions. The ICE is a personal-computer-based system that lets you define and test a number of audio-band filter parameters. The development system then downloads those parameters to a CSC7008 filter.

The ICE system includes menu-driven filter-synthesis software, coefficient-generation software, an in-circuit emulator, and a users manual. One key feature is the development system's ability to dynamically define and test amplitude tolerances, a range of cutoff frequencies (from 0.1 Hz to 10 kHz), several filter types (highpass, lowpass, bandpass, and bandstop), and four filter implementations (Butterworth, Chebyshev I and II, and elliptic filters).

You use the ICE to define the filter parameters and to program CSC7008 universal filters. Each CSC7008 is a digitally configurable, switched-capacitor filter that comes in a 28-pin DIP. Fabricated in CMOS, this audio-band filter is capable of generating eighth-order filter responses.

Once you use the ICE to determine filter coefficients for a CSC7008, you can use a μP to control dynamically those coefficients in your circuit. Alternatively, you can program an external ROM with a fixed set of filter parameters. The CSC7008 can then read the ROM during a self-programming routine initiated at power-on reset. The company plans to release next year an EPROM-based filter that will eliminate any need for off-chip parameter control.

Even a digital designer can produce analog filters *using the Crystal ICE filter-development system. You use the personal-computer-based ICE to define your Butterworth, Chebyshev, or elliptical filter parameters. Then you download those parameters to the 28-pin CSC7008 switched-capacitor filter.*

Unlike discrete filters, the CSC7008 universal filter doesn't drift in RC applications. And unlike other kinds of universal filters, the CSC7008 requires no external components to configure its frequency response. The filter includes two user-configurable op amps for anti-aliasing and smoothing.

For experienced analog-filter designers, the ICE system provides complete design control, including the power to refine the design. By entering biquadratic filter equations or by modifying the results produced in the filter-synthesis process, an experienced analog designer can fine-tune the filter and examine the filter's output response within the context of the ICE circuit emulation.

But even a digitally oriented designer can design a filter with no more information than the required cutoff frequencies, amplitude tolerances, and sampling frequency. The menu-driven software provides step-by-step guidance and lets you build a precise filter response for your circuit in less than an hour.

Because the ICE is a digital system, it lets you precisely specify filter frequencies—even below the hertz level. This filter-development system also offers 1% tolerance for passband corner frequencies. The actual Q factor for the filter will be accurate to within 2% of the calculated value, as long as Q is less than 10.

The ICE filter development system costs $3599. The CSC7008 universal filter costs $30 (100).

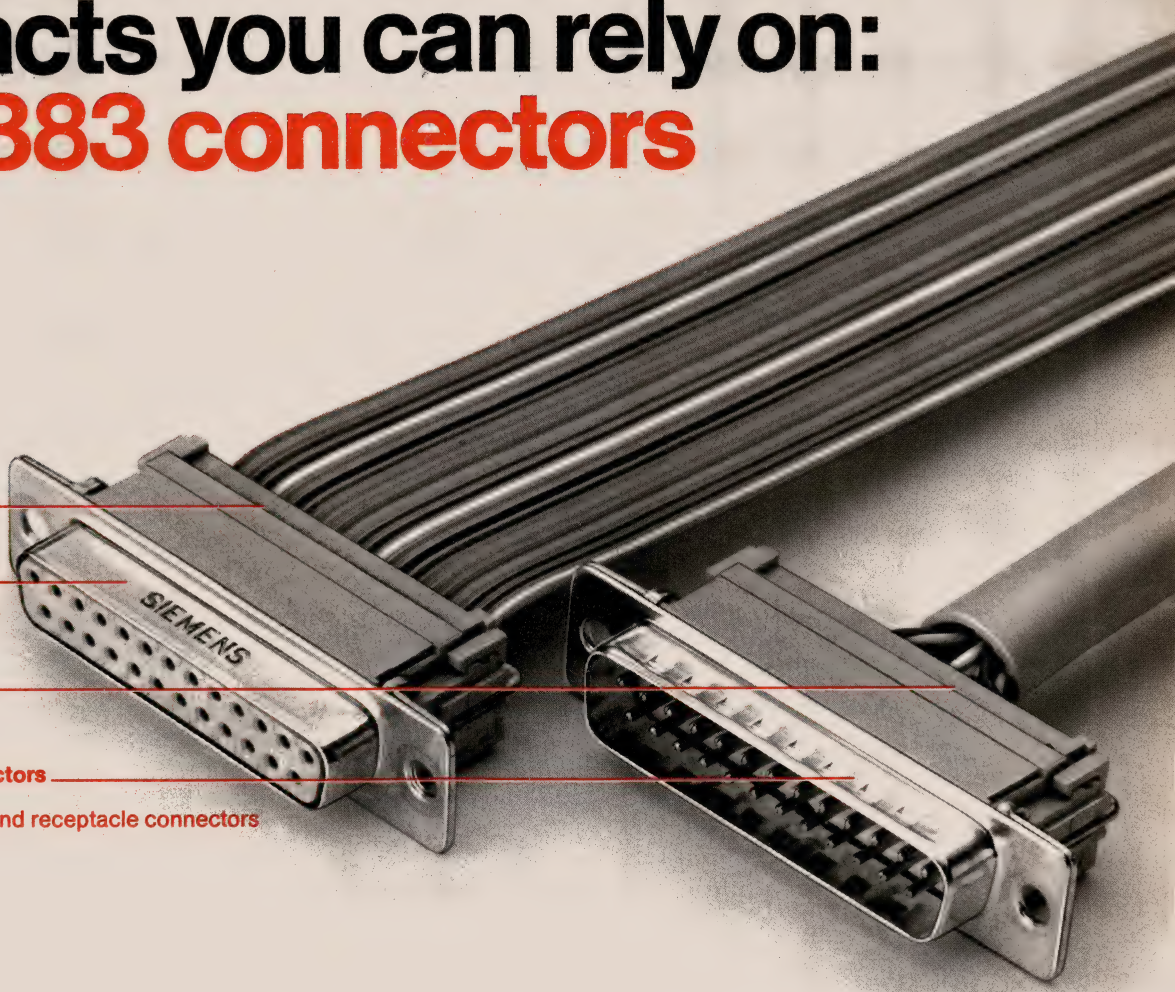
—J D Mosley

Crystal Semiconductor Corp, Box 17847, Austin, TX 78760. Phone (512) 445-7222. TWX 910-874-1352.

Circle No 730

SIEMENS

Contacts you can rely on: SBM 383 connectors



Insulation displacement contacts
for flat cables

Shroud tin-plated
ensures correct mounting

Insulation displacement contacts
for round cables or discrete wires

Spring clips on pin connectors
ensure ground contact between the pin-contact and receptacle connectors

Electronic development engineers expect high quality at low cost from modern connector systems. For this reason high demands are made of the various individual components.

With SBM 383 subminiature connectors Siemens offers a wide range of economically priced products.

- A variety of applications

Applications for SBM 383 connectors are found in telecommunications, text and data processing, as well as in test engineering and instrumentation and control. They are employed as rack and panel connectors, cable connectors and equipment connectors.

- A variety of termination styles

The connectors are available with terminals for soldering, wave-soldering (straight and angled), insulation displacement and crimping.

SBM 383 connectors are compatible with all commercially available SBM connection systems and comply with the latest IEC draft standard 48B (Germany) 99 at requirement levels 2 and 3. With polyester as the insulation material, good temperature stability is achieved.

Should you wish further information, please write to Siemens AG, Infoservice 143/085, Postfach 2348, D-8510 Fürth.

A19100-N621-Z2-V1-7600

Electromechanical components from Siemens

CIRCLE NO 73

80286- and J11-based single-board µCs integrate standard OSs on VME Bus systems

The VMEx 286 and VMEx J11 are the first CPU boards to bring the 80286 and J11 µPs to the VME Bus. The VMEx 286 includes the 80286 µP, the 80287 coprocessor, and 512k bytes of RAM, allowing you to run code written for 80286-based systems on a VME Bus system. Similarly, the VMEx J11 implements the RSX-11M operating system by incorporating the J11 µP and 512k bytes of RAM.

Both cards can operate as VME Bus arbiters, requesters, and interrupt handlers. The VMEx J11 can also operate as a VME Bus controller. The VMEx 286 uses a control-and-status register and the µP's memory-management circuitry to implement multitasking, multiuser operating systems (Xenix and iRMX) in addition to single-user operating systems (MS-DOS and CP/M-86).

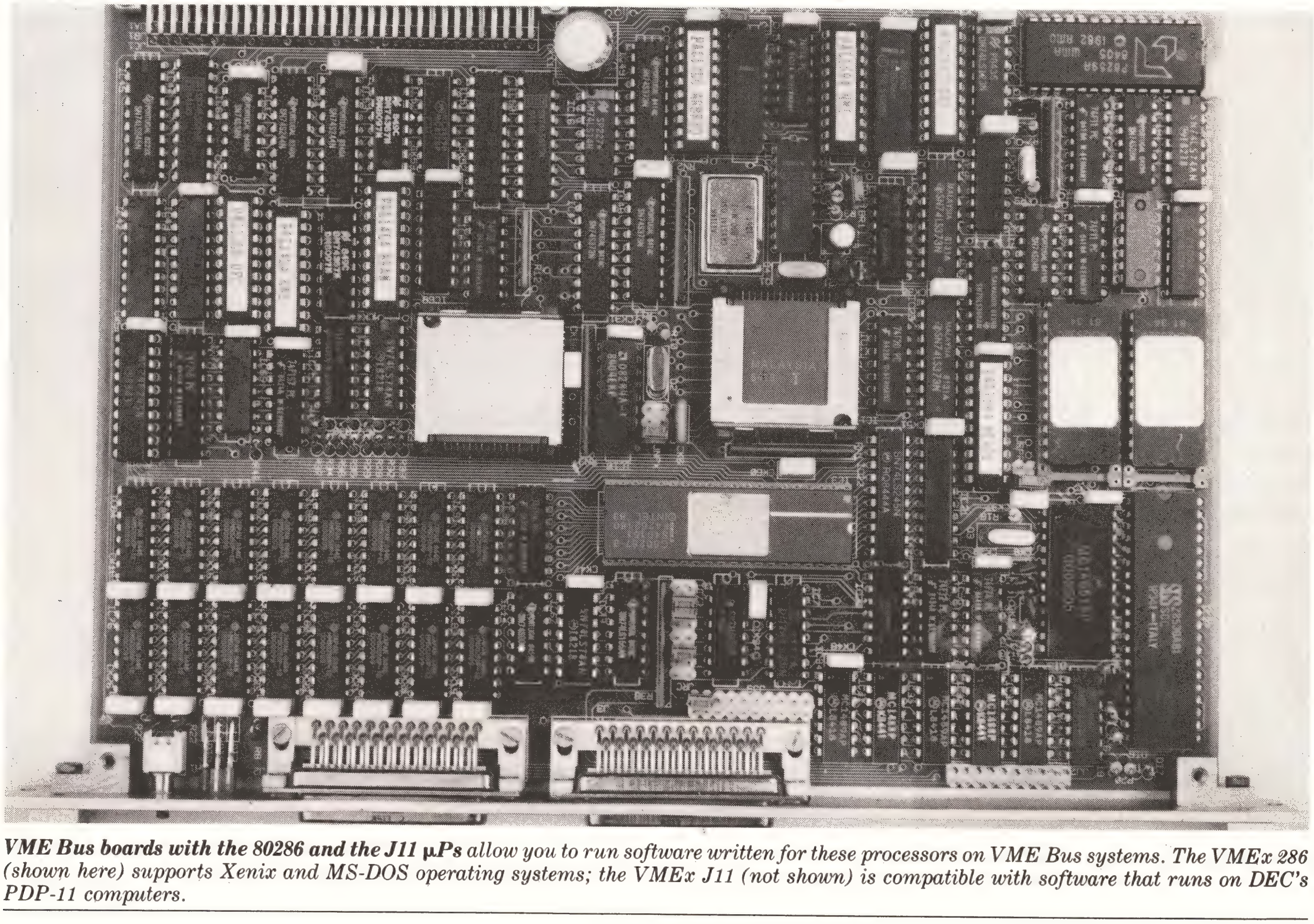
The VMEx J11 is software compatible with all DEC PDP-11 computers, according to the vendor. As a VME Bus controller, the board allows you to put together single- and dual-processor VME Bus systems. The board contains a memory-management unit, an RS-232C serial port, a Centronics parallel port, and three programmable timers. A real-time clock counts seconds, minutes, hours, days, months, and years, and it implements a time-of-day alarm and VME Bus battery backup.

Other hardware on the VMEx 286 includes a real-time clock similar to the one on the VMEx J11, sockets for 64k bytes of EPROM, and two RS-232C serial ports. It costs $2280, including built-in self-diagnostics, a system monitor, and manuals. The VMEx J11, with self-diagnostics, debugging software, and manuals, costs $2395.

—David Smith

Iskra VME Technologies, 222 Sherwood Ave, Farmingdale, NY 11735. Phone (516) 753-0400.

Circle No 727



VME Bus boards with the 80286 and the J11 µPs *allow you to run software written for these processors on VME Bus systems. The VMEx 286 (shown here) supports Xenix and MS-DOS operating systems; the VMEx J11 (not shown) is compatible with software that runs on DEC's PDP-11 computers.*

What in the world can you do with Plessey Microsystems VMEbus processor boards?

Everything!

If you have a VMEbus processing application, Plessey Microsystems has your VMEbus processor. Now!

No wait state 68020 processor that runs at a blisteringly fast 25 MHz.

Innovation doesn't end there. The PME 68-21 also has a VSB interface which allows you to take full advantage of this processor's speed. It's the perfect processor for vision systems, process control, real-time simulation and high-speed number crunching.

GPIB/IEEE-488 single board computer . . . and intelligent controller.

Ideal for instrumentation control applications and data acquisition, the PME 68-14 integrates IEEE-488 interface, 68000/68010 processor, memory and VMEbus system controller functions on one board providing higher performance at lower cost.

A powerful high-speed single board computer with 4 Mbytes of dual-ported RAM.

Our versatile PME 68-12 provides the nucleus for a compact, efficient data acquisition workstation and other applications requiring a floppy disk controller, programmable real-time clock and complete serial/parallel I/O control.

A general purpose workhorse ideal for process control.

The PME 68-1B is a 16 bit single board computer with up to 512 Kbytes of on-board DRAM, RS 232 communications, 24-bit parallel port with counter/integral timer and more.

The industry's most cost-effective stand-alone workstation.

The PME 68-2 single-board computer makes short work of data acquisition tasks.

Data acquisition, coprocessing and other multiprocessor environments.

Our PME 68-2D gives you up to 512 Kbytes of dual-ported RAM, and full system controller functions. Selecting or eliminating options on this processor allows you to develop the most cost-effective multiprocessor system.

The perfect UNIX engine, designed to optimize the performance of system hardware and software.

The PME 68-15 is a fast, efficient cache processor board aimed for the multi-user, multi-tasking environment, supporting up to 16 processes simultaneously. On-board discrete MMU, UART and a sophisticated dual cache with least-used algorithm improves system and CPU performance over the full address range of the processor.

A World of VMEbus Processors for You!

Call us now or use the coupon below to get details on the fastest, most powerful processors in the VMEbus world. Plus a full range of VMEbus memory, controllers and I/O development systems and software. So what in the world are you waiting for?

PLESSEY

PLESSEY and the Plessey symbol are registered trademarks of The Plessey Company plc.

UK
Water Lane
Towcester
Northants
NN12 7JN
(0327) 50312

USA
One Blue Hill Plaza
Pearl River
New York 10965
(914) 735 4661

France
7-9 rue Denis Papin
78190 Trappes
(1) 30. 51.49.52

Germany
Bahnhofstraβe 38
6090 Rüsselsheim
(0 61 42) 6 80 04

CIRCLE NO 74

For additional information, clip and mail to Plessey Microsystems Ltd., Water Lane, Towcester, Northants, UK NN12 7JN

Name
Company
Address
Title
Phone
Postcode

EDN62686

Standard-cell library includes UARTs, RAMs, PLAs, and gate-array cells

Using the SCL library of standard cells, you can incorporate the 16450 UART, single- and dual-port RAMs, programmable-logic arrays (PLAs), and random logic in a semicustom-IC design. Furthermore, the vendor plans to add its HPC and COPS microcontroller products as standard cells (called functional blocks) to the library by the end of the year, in addition to 100 additional SSI and MSI cells, RAM and PLA generators, 2900 Series bit-slice devices, and analog functions.

Built in a 2-μm CMOS technology, the cells feature minimum propagation delays as short as 0.9 nsec and flip-flop toggle frequencies as high as 150 MHz. ICs designed with the library operate from a voltage supply between 3 and 6V and over a temperature range of −55 to +125°C.

New products become cells

Because all of the company's new LSI and VLSI products are built in this CMOS technology, these products will eventually be available as cells to work with the library. They include the Series 32000 microprocessors, 8051-type microcontrollers, hard- and floppy-disk controller circuits, and LAN circuits. Special-purpose functions such as A/D and D/A converters and EEPROM cells will also become available.

To test semicustom chips that contain large functional blocks, the vendor includes test circuitry that allows you to isolate the blocks during test. You can then test the blocks using vendor-supplied test routines.

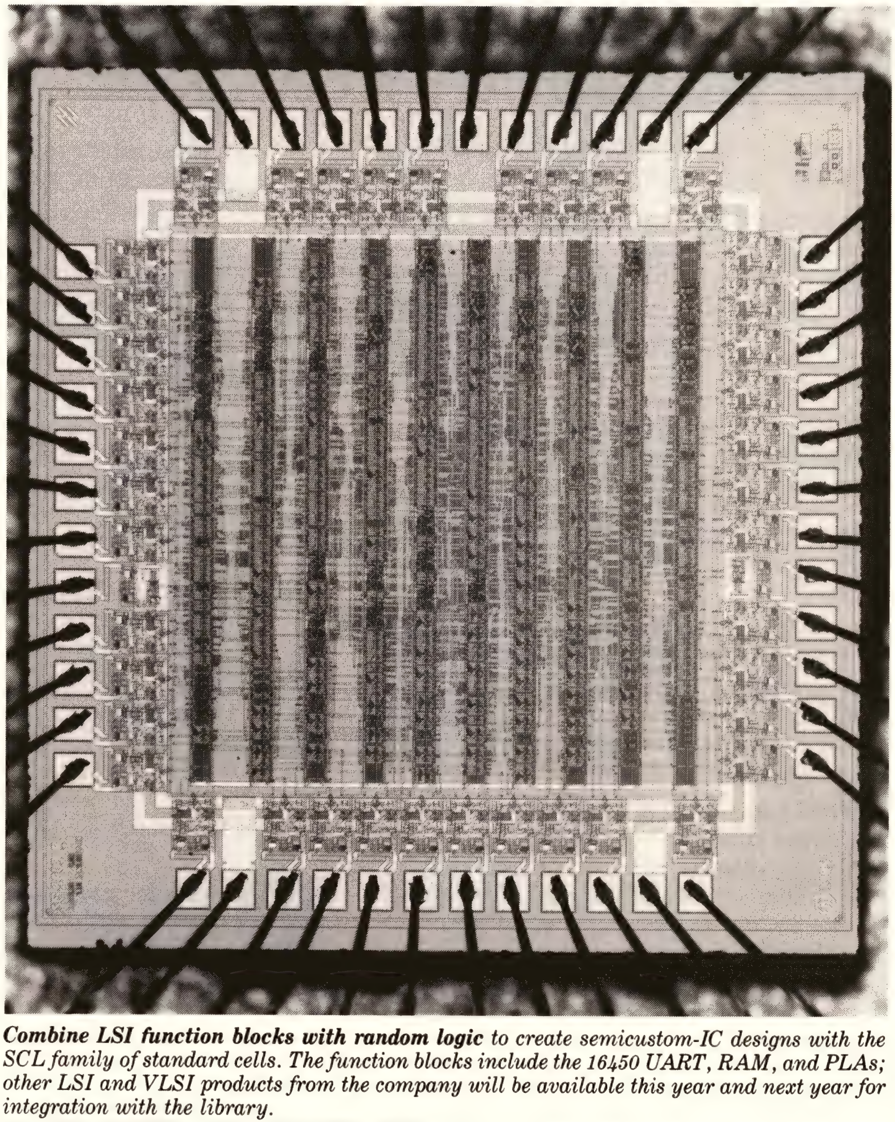
The library's MSI and SSI functions include all 150 cells found in the vendor's gate-array libraries. A gate-array design with the vendor's libraries, therefore, can be recompiled automatically as a standard-cell IC design without any redesign. The vendor estimates that the conversion results in a 30 to 50% smaller die.

The standard-cell ICs are packaged in DIPs, plastic chip carriers, leadless chip carriers, ceramic pin-grid arrays, and the vendor's Tape-Pak package for automated manufacturing equipment. After you approve the final IC simulation, the vendor delivers tested prototypes in eight to 10 weeks. Production units cost $0.002 to $0.003 per gate.

—David Smith

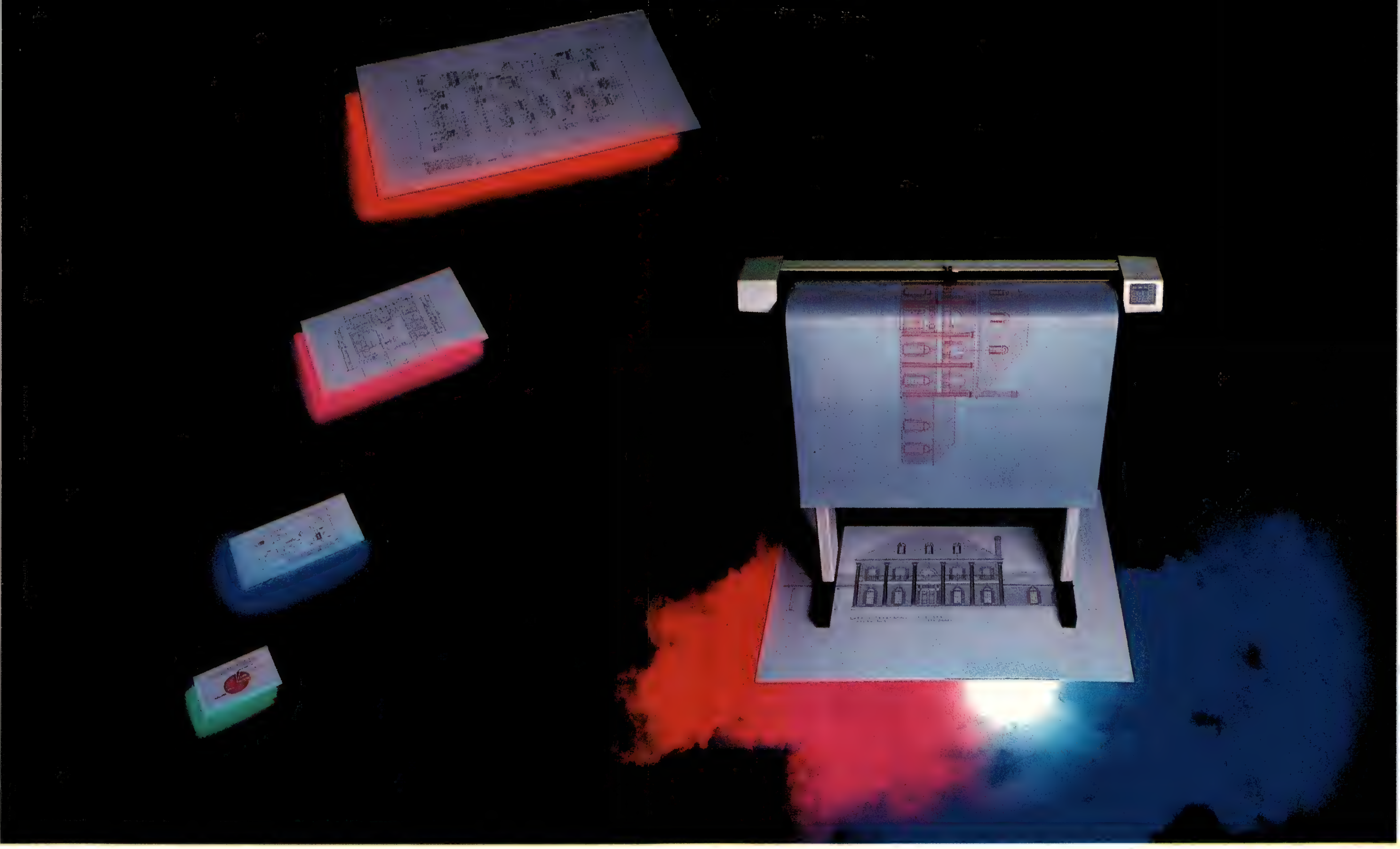
National Semiconductor Corp, Box 58090, Santa Clara, CA 95052. Phone (408) 721-5000. TWX 910-339-9240.

Circle No 728



Combine LSI function blocks with random logic *to create semicustom-IC designs with the SCL family of standard cells. The function blocks include the 16450 UART, RAM, and PLAs; other LSI and VLSI products from the company will be available this year and next year for integration with the library.*

STEP UP TO E SIZE



Houston Instrument's new E size DMP-56 delivers the precision, throughput, and reliability you require from a drafting-intensive plotter. The DMP-56 also gives you the flexibility to handle 18 different drawing format sizes ranging from 8½ × 11 inches to 36 × 48 inches.

The DMP-56 was designed for any application calling for crisp, clean graphics—whether it's architectural floorplans, mechanical designs, electrical schematics, or overhead transparencies. Because of its media-size adjustment mechanism and automatic media-size sensing feature, the DMP-56 quickly and efficiently responds to your changing format requirements. This high-performance plotter can produce standard (A through E), metric (A4 through A0), oversize (A4 through A0), and Architectural C, D, and E drawings.

The DMP-56 is a professional drafting plotter that draws on the established track record of Houston Instrument's very successful DMP-51/52 and DMP-51/52 MP plotters—plotters that redefined the standard for price, performance, and quality.

Immediately compatible with hundreds of computer-aided design and graphics software packages through our powerful DM/PL™ command language, the DMP-56 also gives you a precise resolution of .001 inch and a maximum plotting speed of 17 inches per second. And, because it uses a standard RS-232-C compatible interface, the DMP-56 can operate with virtually any computer on the market.

The DMP-56 also delivers features you'd expect only from more expensive* plotters—such as quiet servo drive, and an easy-to-use front-panel control. Combine these standard features with the well-known Houston Instrument reliability and support and you have a superior plotter at a reasonable price.

In terms of throughput, performance, price, and quality the DMP-56 is the professional graphics tool you need. For more information, call 1-800-531-5205 (512-835-0900 if in Texas), or write Houston Instrument, 8500 Cameron Road, Austin, Texas 78753. In Europe, contact Houston Instrument, Belgium NV., Rochesterlaan 6, 8240 Gistel, Belgium. Tel.: 32-(0)59-277445. Tlx.: 846-81399.

*U.S. suggested retail price is $5,995. Pricing subject to change.
DM/PL is a trademark of Houston Instrument.

houston instrument
A Division of AMETEK

CIRCLE NO 75

Don't buy any I/O Module until you evaluate Grayhill!

You'll find outstanding specs, performance, pricing and availability in these new I/O Modules . . . from Grayhill or your local Grayhill distributor, in all standard configurations. All are compatible with 5, 15 or 24V logic circuits.

AC output	120V or 240V	black case
DC output	3V to 60V	red case
AC input	120V or 240V	yellow case
DC input	3V to 32V	white case

Prove it to yourself . . . ask us for free literature with complete product specifications and prices.

Grayhill INC
561 Hillgrove Avenue, P.O. Box 10373
LaGrange, Illinois 60525-0373 USA
Phone: (312) 354-1040 TLX: 6871375
TWX: 910-683-1850 FAX: (312) 354-282

AVAILABLE LOCALLY THROUGH THESE REPRESENTATIVES

AUSTRALIA/NEW GUINEA Acme Engineering
Kilsyth, Victoria • Tel: (03) 890-0900
BELGIUM/LUXEMBOURG Rodelco SA/NV Electronics
Brussels • Tel: 02-2166330
CHINA, REPUBLIC OF Morrihan International
Taipei • Tel: (02) 752-2200
DENMARK E.V. Johanssen Elektronik A-S
Copenhagen • Tel: (01) 83 90 22
FRANCE Radio Television Francaise
Gentilly • Tel: (014) 664.11.01
FINLAND OY Flinkenberg & Co., AB
Helsinki • Tel: (90) 647-311
GERMANY Data Modul GmbH
München • Tel: (089) 56 01 70
HONG KONG Components Agent Ltd.
Hong Kong • Tel: (0) 4992688
INDIA Hindco Corporation
Bombay • Tel: (22) 493-1544
ISRAEL Rapac Electronics, Ltd.
Tel Aviv • Tel: (03) 477115
ITALY Microelit s.r.l.
Milano • Tel: (02) 46 90 444
Rome • Tel: (06) 890892
JAPAN Jepico Corp.
Tokyo • Tel: (03) 348-0611
NETHERLANDS Rodelco BV Electronics
Breda • Tel: (076) 784911
NEW ZEALAND S.D. Mandeno
Auckland • Tel: (09) 600-008
NORWAY Hans H. Schive A/S
Nesbru • Tel: (02) 84 51 60
SINGAPORE, REPUBLIC OF Microtronics Associates Ltd.
Singapore • Tel: 7481835
SOUTH AFRICA, REPUBLIC OF Liberty Electronics Ltd.
Boksburg • Tel: (11) 52-7637
SOUTH KOREA Unistandard Corporation
Seoul • Tel: (02) 532-6815
SPAIN Unitronics SA
Madrid • Tel: (01) 242 52 04
SWEDEN Bo Palmblad Aktiebolag
Bromma • Tel: (08) 25 27 20
SWITZERLAND Walter Blum AG
Zurich • Tel: (01) 312 68 72
UNITED KINGDOM Highland Electronics, Ltd.
Burgess Hill, West Sussex • Tel: (044 46) 4502

CIRCLE NO 76

VME Bus 32032 CPU board offers I/O, FPU, and MMU

Based on the 32000 µP family from National Semiconductor, the 32032V VME Bus CPU board includes memory, I/O, and software. The CPU board employs a 10-MHz 32032 µP, which is supported by both National Semiconductor and Texas Instruments. Diagnostic software, monitor software, and a real-time operating system accompany each board.

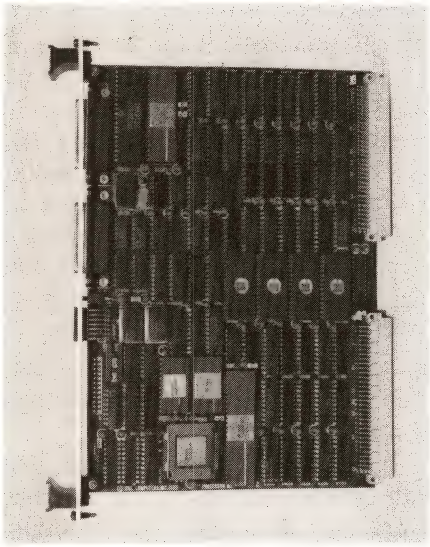
The CPU board also includes the 32201 timing-control unit (TCU), and the 32202 interrupt-control unit (ICU). The 32081 floating-point unit (FPU) and the 32082 memory-management unit (MMU) are optional.

The 32032V processor board operates as a VME Bus master and supports a 32-bit data bus and a 24-bit address bus. You can install a maximum of 128k bytes of EPROM in onboard sockets. The software provided with the board occupies 8k bytes of the 128k-byte maximum.

The optional MMU implements a demand-paged virtual memory scheme, which provides memory protection for each user and for the operating systems. The MMU also supports a 16M-byte virtual-memory area. The FPU provides IEEE-standard 32- and 64-bit floating-point arithmetic. The board also includes two serial channels, two programmable timers, and eight option switches that the CPU can read.

The hardware design includes support for multiple virtual machines (MVM). In MVM schemes, multiple operating systems execute simultaneously on one processor.

On the 32032V board, one EPROM holds the diagnostics, monitor, and real-time operating system. The monitor provides control and debugging capabilities. The user can, for example, use the monitor to display or change registers or main memory.



Diagnostic software, monitor software, and a real-time operating system *accompany each 32032V VME Bus board from Owl Computers. The board includes a 32-bit µP, memory, and I/O capabilities.*

The board's standard operating system, National Semiconductor's Exec, has multitasking real-time capabilities. It allows as many as 256 levels of task priority and 256 logical communication channels.

Cross-development software for MS-DOS or CP/M hosts is optional. The NSX-32 software library includes an assembler and C and Pascal compilers. The library also offers a linker, librarian, file-conversion utility, debug-support package, and hex-file load utility.

The 32032V board and software are available from stock. Without the FPU or MMU, the CPU board costs $2550 (100). The company offers one board to each customer for evaluation at the 100-piece price.

—***Maury Wright***

Owl Computers Inc, 640 Crest Dr, Encinitas, CA 92024. Phone (619) 436-4214.

Circle No 731

CAD GENERATED DESIGN

- ANALOG
- DIGITAL
- MULTILAYER
- SMT
- HYBRIDS
- DOCUMENTATION
- PROTOTYPE
- BOARD FABRICATION

Quick Turn-Around
Competitive Prices !

Century Cad Systems
1726 W. 15th St. Santa Ana
CA 92706 (714) 667-7891

CIRCLE NO 77

DID YOU KNOW?

EDN's editorial staff is backed by 182 cumulative years of technical experience and nearly 170 years of journalistic experience.

EDN

epo-tek®

THE NEED

A high quality epoxy with very specific performance requirements.

THE SOURCE

EPO-TEK epoxies from Epoxy Technology.

In electronics, microelectronics, optics, optoelectronics or any application which requires an epoxy with specific performance parameters, trust EPO-TEK epoxies from Epoxy Technology Inc. (EPO-TEK epoxies are also used in the professional restoration of valuable glass, ceramic and wood artifacts.)

Call or send for our free product brochures.

Optics, optoelectronics brochure

Electronics, microelectronics brochure

No one knows more about epoxies than Epoxy Technology.

epoxy technology inc

(800) 227-2201
14 Fortune Drive
Billerica, MA 01821
(617) 667-3805
in Massachusetts

epoxies

CIRCLE NO 78

30V, 30-mΩ power MOSFETs suit battery-powered circuits

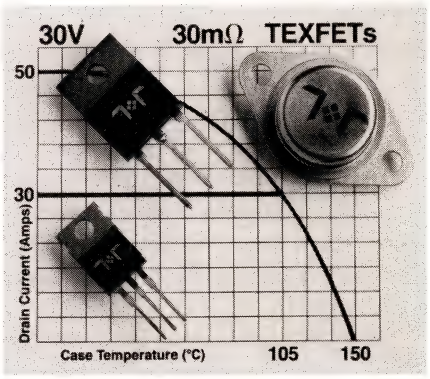
The 12 members of the 30^3 (Thirty-Cubed) family of low-cost power MOSFETs are suitable for use in battery-powered circuits. The ICs can function in 12V systems as emitter switches in cascode circuits or as variable load controllers. According to the manufacturer, the MOSFETs let you extend usable battery life in PWM motor-control circuits by as much as 300% over the usable battery life in systems using resistive-control techniques.

In battery-powered circuits, you can typically optimize on-resistance by using a 10V gate drive. In single-supply applications, the available gate drive falls as the battery discharges, and the effective on-resistance increases, thereby changing the load current. However, the low on-resistance offered by the Thirty-Cubed devices (such as the 30-mΩ TX30N03P and TX50N03H) eases the current transitions to the load as the gate drive diminishes.

You can also use these MOSFETs to provide thermal management in applications in which heat-sink size and cost would otherwise be troublesome. The 30V versions can maintain a 30A drain current at case temperatures as high as 105°C.

Thirty-Cubed power MOSFETs are fabricated in the company's n-channel, vertical-DMOS technology. Typical applications for the devices include control circuits that are generally free of large voltage transients. The ICs are available in TO-204 metal packages or in TO-218 or TO-220 plastic packages.

Prices for the ICs range from $1.38 (1000) for a 20V, 25A, 35-mΩ TX25NO2P to $5.52 (1000) for a 30V, 50A, 30-mΩ TX50N03M. The two parts come in a TO-220 and a TO-204 package, respectively. A TX50N03H, which offers 30V, 50A, and 30 mΩ and comes in a TO-218 plastic package, costs $3.11. The 30V, 30A, 30-mΩ TX30N03P comes in a TO-220 package and costs $1.81 (1000). Delivery, eight weeks ARO.—***J D Mosley***

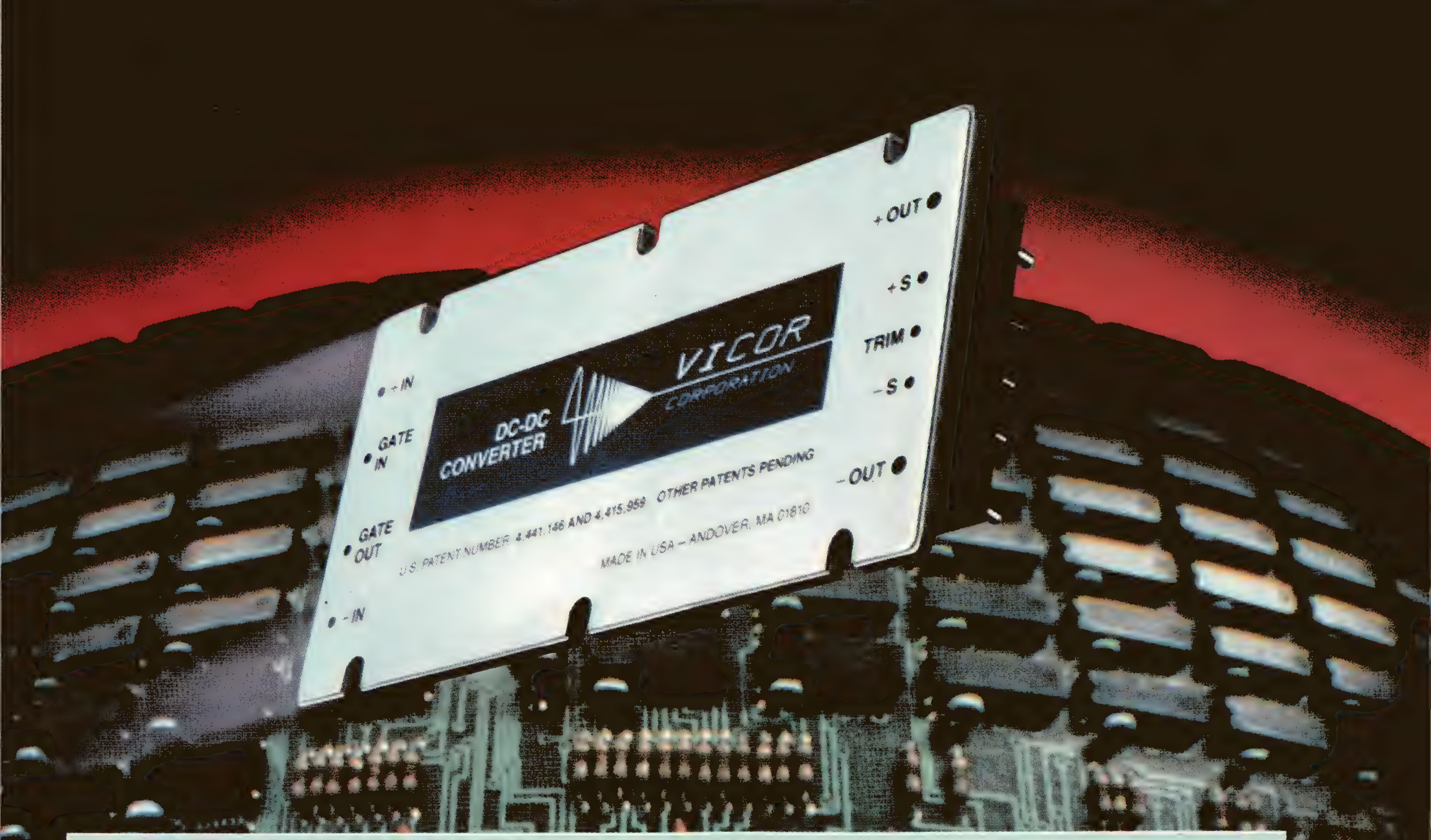


Available in either plastic or metal packages, *the 30^3 (Thirty-Cubed) power MOSFETs offer economical thermal management. The ICs reduce load-current fluctuations in battery-powered systems.*

Texet Semiconductors, 301 Texet Dr, Allen, TX 75002. Phone (214) 727-1111.

Circle No 722

Power Components Up To 50 Watts/Cubic Inch


+IN
GATE IN
GATE OUT
-IN
DC-DC CONVERTER
VICOR CORPORATION
U.S. PATENT NUMBER 4,441,146 AND 4,415,959 OTHER PATENTS PENDING
MADE IN USA – ANDOVER, MA 01810
+OUT
+S
TRIM
-S
-OUT

See Where VICOR's MHz Switchers Can Take You . . .

Vicor's AC/DC and DC/DC converters will take you to the leading edge of power conversion technology. Consider the benefits of our power components in your system:

SIZE—A dramatic reduction in converter volume and weight is achieved with MHz switching frequencies. Vicor's VI Series of converters (shown actual size) deliver as much as 200W from a package measuring 2.4″ x 4.6″ x 0.47″ and weighing less than 1/3 of a pound. The converters have power densities as high as 50W/in^3, allowing you to design a system that is significantly smaller and lighter than your competitor's using yesterday's power conversion technology.

EFFICIENCY—Vicor converters have conversion efficiencies of 80 to 90%. Higher efficiency reduces heat generated in your system making it cooler and more reliable.

FLEXIBILITY—Vicor converters support applications ranging from low power battery equipment to multi-kilowatt off-line power systems with input voltages from 10 to 425 VDC, and isolated outputs from 5 to 48 VDC. Booster modules allow you to configure power systems that are expandable in 200W increments.

RELIABILITY—With 50,000 modules in the field over a year, the failure rate is less than 0.1%.

QUALITY—Our reputation for quality begins with the design; there are no limited-life components in VI Series converters. Quality is maintained in production with the latest functional testers and burn-in equipment. Each module is tested and trimmed by ATE.

VI-100™ Converters and VIB-00 Power Boosters™, manufactured by Vicor and its licensees, represent the state-of-the-art in power conversion technology. See what smaller size, higher efficiency, and modular component flexibility can do for your next power system design. Call (0734) 868567, TWX: 847073 POWLIN G, FAX: (0734) 755172.

Distributed by: POWERLINE ELECTRONICS, LTD.

VICOR CORPORATION

5 Nimrod Way
Reading, RG2 0EB
ENGLAND

VICOR – Component Solutions For Your Power System.

CIRCLE NO 79

IF YOU'RE ONLY LOOKING AT GATE ARRAYS, YOU'RE NOT SEEING THE WHOLE PICTURE.

The only way to make sure you get the right ASIC solution is to call the only place that has them all. VLSI Technology. Ask for our brochure on programmable logic, gate arrays, standard cells, megacells, silicon compilation, design tools, and manufacturing. It'll really open your eyes.

1109 McKay Drive, San Jose, CA 95131, 800-535-1860
(In California: 800-862-1860) Dept. 700

VLSI Technology, Inc.
Not just your basic ASIC.

CIRCLE NO 80

We're selling the

Here are two ways to take advantage of our disk and tape controller technology.

Designer's dilemma: Buy vs. Build.

Should you get to market quickly, using one of our fully assembled and tested disk controller boards? Or should you go for the flexibility of integrating our VLSI controllers and support devices into your own design?

Either way, you win when the first thing you do is call Western Digital.

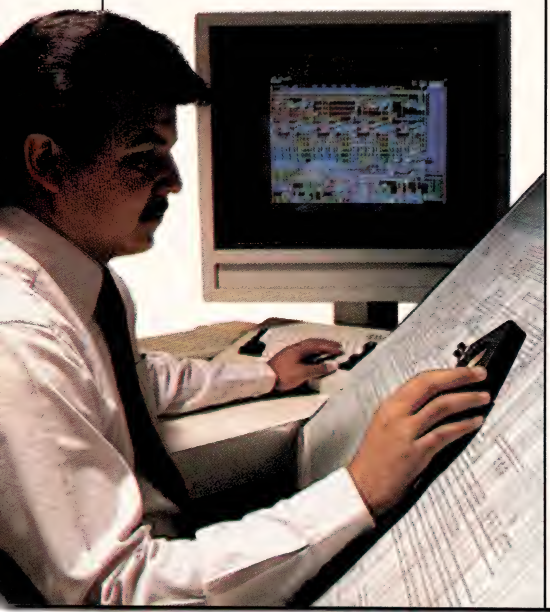
We're proud of the success we've had supplying leading microsystem builders with disk controller boards.

We're even prouder of our family of VLSI devices. They're the true secret of our success. And they're all for sale.

Ride down the experience/cost curve with our VLSI devices while we push them up the function integration curve.

The pace is quickening. Our chip engineers have been busy. Right now we're introducing new VLSI devices at an especially rapid pace.

That includes more highly integrated hard and floppy disk controllers, both with on-board data separators. (Neat trick, huh?) A single



Our VLSI designers are among the most creative in the industry, and have the most powerful tools to work with.

WD1002A-WX1 4.95" x 3.85" half-slot IBM XT compatible controller for up to two ST506 drives.

WD30C30/31 CMOS ST506/RLL Hard disk controllers with on-chip ECC and analog data separator.

WD3600 CMOS streaming drive controller with QIC-36 interface.

secret to our success.

chip controller that turns SCSI from scuzzy to sexy. A new QIC-36 streaming tape controller device. And an RLL hard disk controller with 56-bit ECC.

Our board engineers have been busy too. Integrating our new VLSI into solutions that address the emerging high performance disk markets of (2,7) RLL and ESDI, as well as new technologies such as optical.

Up the function. Down the cost.

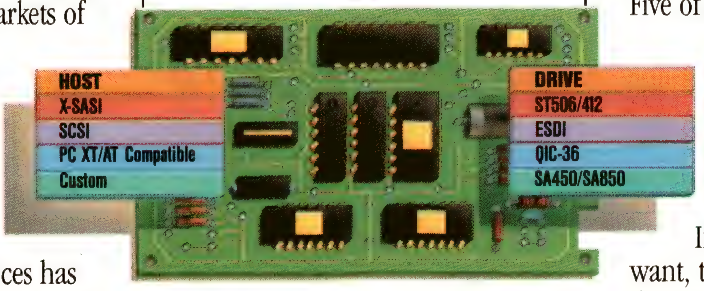
Being our own biggest customer for our VLSI devices has taught us a lot about what our chip level customers need and want.

Such as devices that are easy to design with and easy to test. And that have a built-in promise of follow-on solutions that drive down the cost of your system design and manufacturing costs by giving you more for less.

No secrets.

Our VLSI devices come with systems level support, to help you get to market quickly. Because we design our devices with system issues in mind, and sort out design considerations for our own board-level products, we can help you integrate our devices into your system.

As a matter of fact, start with our board-level solutions, for accelerated market entry and reduced start-up cost, and we'll help you build your own boards based on our chips as soon as you're ready. We'll even license our microcode, saving you man-years of development time and hard-knocks experience.



Choose your interface. Our VLSI solutions provide the foundation for a family of boards supporting all popular host and drive interfaces.

That promise is backed with more technical people working on-site with customers than any controller manufacturer in the world. And more in-house applications engineers that live and die by the motto, "we succeed when you succeed."

Make our success yours.

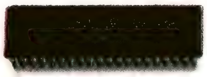
Five of our newest VLSI developments are detailed at the bottom of this ad, along with three of our new board-level designs based on our ever-growing family of devices.

If you don't see what you want, though, we'll even entertain the notion of developing custom VLSI and board-level products for you.

To arrange for samples, call our Western Regional Sales Office at (714) 851-1221 or our Eastern Regional Sales Office at (612) 835-1003. Or, for more literature, write Western Digital Corporation, Literature Dept., 2445 McCabe Way, Irvine, CA 92714.

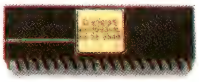
WESTERN DIGITAL
CORPORATION

WD5011-10 ST506 Hard disk controller/formatter using 2,7 RLL encoding and on-chip 56-bit ECC.

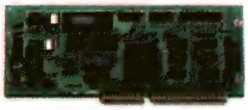


WD37C65 CMOS Floppy disk controller with on-chip digital data separator. NEC765A compatible.

WD1005-SCS SCSI interface controller for up to four ESDI drives with powerful 56-bit ECC.



WD33C93 CMOS SCSI bus interface controller with on-chip high current drivers.



WD1003-WAH 100% PC AT compatible hard disk controller for up to two ST506 drives.

CIRCLE NO 81

LEADTIME INDEX

Percentage of respondents

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Average (weeks)	Last month's average (weeks)
TRANSFORMERS								
Toroidal	5	16	63	16	0	0	7.9	7.2
Pot-Core	0	23	54	23	0	0	8.5	7.8
Laminate (power)	0	26	48	26	0	0	8.5	8.3
CONNECTORS								
Military panel	0	11	45	33	11	0	12.0	6.2
Flat/Cable	22	44	28	6	0	0	4.0	4.3
Multipin circular	0	33	42	25	0	0	8.0	8.1
PC	0	46	46	8	0	0	5.8	4.4
RF/Coaxial	7	43	21	29	0	0	7.1	5.6
Socket	23	59	9	9	0	0	3.4	3.5
Terminal blocks	11	39	33	17	0	0	6.1	4.5
Edge card	20	40	27	13	0	0	5.1	4.3
Subminiature	13	50	31	6	0	0	4.5	5.8
Rack & panel	11	33	45	11	0	0	6.0	5.6
Power	17	58	17	8	0	0	3.8	3.1
PRINTED CIRCUIT BOARDS								
Single-sided	0	71	29	0	0	0	3.7	4.1
Double-sided	0	44	56	0	0	0	5.4	5.0
Multilayer	0	25	69	6	0	0	7.0	5.7
Prototype	4	82	14	0	0	0	2.7	2.4
RESISTORS								
Carbon film	38	35	27	0	0	0	2.8	3.6
Carbon composition	30	30	31	9	0	0	4.4	4.3
Metal film	35	35	30	0	0	0	3.1	3.4
Metal oxide	30	20	40	10	0	0	5.2	4.2
Wirewound	19	24	48	9	0	0	5.8	4.9
Potentiometers	10	48	35	7	0	0	4.8	4.1
Networks	10	45	45	0	0	0	4.5	2.4
FUSES	46	18	36	0	0	0	3.3	3.1
SWITCHES								
Pushbutton	15	55	20	10	0	0	4.3	4.2
Rotary	20	47	20	13	0	0	4.7	7.4
Rocker	14	57	22	7	0	0	4.0	4.6
Thumbwheel	0	64	27	9	0	0	4.9	4.5
Snap action	15	46	23	16	0	0	5.2	4.9
Momentary	0	64	18	18	0	0	5.6	5.1
Dual in-line	8	50	25	17	0	0	5.7	4.4
WIRE AND CABLE								
Coaxial	33	47	20	0	0	0	2.5	1.9
Flat ribbon	32	47	21	0	0	0	2.6	2.6
Multiconductor	12	47	35	0	6	0	5.3	3.0
Hookup	59	33	8	0	0	0	1.3	1.4
Wire wrap	40	40	20	0	0	0	2.4	2.0
Power cords	19	43	29	9	0	0	4.7	4.6
Other	17	33	50	0	0	0	4.7	6.3
POWER SUPPLIES								
Switching	0	27	60	13	0	0	7.5	6.5
Linear	19	19	56	6	0	0	5.9	6.0
CIRCUIT BREAKERS	20	20	33	27	0	0	7.3	7.7
HEAT SINKS	14	48	33	5	0	0	4.4	4.7

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Average (weeks)	Last month's average (weeks)
RELAYS								
General purpose	33	17	39	11	0	0	5.2	5.4
PC board	0	33	33	34	0	0	8.7	7.5
Dry reed	0	29	71	0	0	0	6.3	6.7
Mercury	40	20	40	0	0	0	3.6	6.0
Solid state	15	31	31	23	0	0	6.8	8.3
DISCRETE SEMICONDUCTORS								
Diode	28	33	30	9	0	0	4.5	4.8
Zener	24	40	24	8	0	4	5.2	4.5
Thyristor	8	33	42	17	0	0	6.7	5.8
Small signal transistor	25	30	25	20	0	0	5.8	5.9
FET, MOS	23	23	23	31	0	0	7.2	7.3
Power, bipolar	17	42	25	16	0	0	5.5	7.5
INTEGRATED CIRCUITS, DIGITAL								
CMOS	8	42	33	17	0	0	6.2	5.8
TTL	10	40	40	10	0	0	5.6	6.2
LS	5	40	25	30	0	0	7.6	6.1
INTEGRATED CIRCUITS, LINEAR								
Communication/Circuit	0	40	47	13	0	0	6.7	8.4
OP amplifier	10	32	42	16	0	0	6.5	7.0
Voltage regulator	10	45	30	15	0	0	5.7	6.4
MEMORY CIRCUITS								
RAM 16k	29	21	29	21	0	0	6.1	7.7
RAM 64k	21	36	36	7	0	0	4.7	8.7
RAM 256k	7	27	46	20	0	0	7.5	7.4
ROM/PROM	20	33	34	13	0	0	5.5	9.0
EPROM	14	29	38	19	0	0	6.7	5.9
EEPROM	18	27	37	18	0	0	6.4	7.9
DISPLAYS								
Panel meters	8	31	38	23	0	0	7.4	6.0
Fluorescent	13	25	37	25	0	0	7.5	11.4
Incandescent	11	56	22	11	0	0	4.7	7.8
LED	20	40	35	5	0	0	4.4	5.3
Liquid crystal	9	18	55	18	0	0	7.6	6.4
MICROPROCESSOR ICs								
8-bit	18	23	41	18	0	0	6.6	6.1
16-bit	14	29	50	7	0	0	5.7	6.9
FUNCTION PACKAGES								
Amplifier	9	46	27	18	0	0	6.0	8.2
Converter, analog to digital	8	42	25	25	0	0	6.8	7.4
Converter, digital to analog	0	46	27	27	0	0	7.5	8.4
LINE FILTERS	27	9	46	18	0	0	6.7	7.5
CAPACITORS								
Ceramic	26	31	35	8	0	0	4.6	3.9
Ceramic monolithic	21	33	33	13	0	0	5.3	4.1
Ceramic disc	29	25	38	8	0	0	4.8	4.9
Film	18	27	46	9	0	0	5.6	5.7
Electrolytic	23	23	42	12	0	0	5.7	6.7
Tantalum	21	25	50	4	0	0	5.1	6.0
INDUCTORS	20	33	40	7	0	0	4.9	6.1

Source: *Electronic Purchasing* magazine's survey of buyers

TECHNOLOGY BREAKS THE PRICE BARRIER

EIE PHOTOPLOTTER P30

The leading photoplotter for PCB applications.

EIE's P30 photoplotter combines precision and technical quality at an unrivalled price performance ratio.

Engineered to expose printed-circuit manufacturing films at micron resolution, the P30 functions on-line via a standard RS232C interface or off-line from magtape data.

Intelligence, programmed into the P30's microprocessor, ensures speed, flexibility and a wide range of automatic functions.

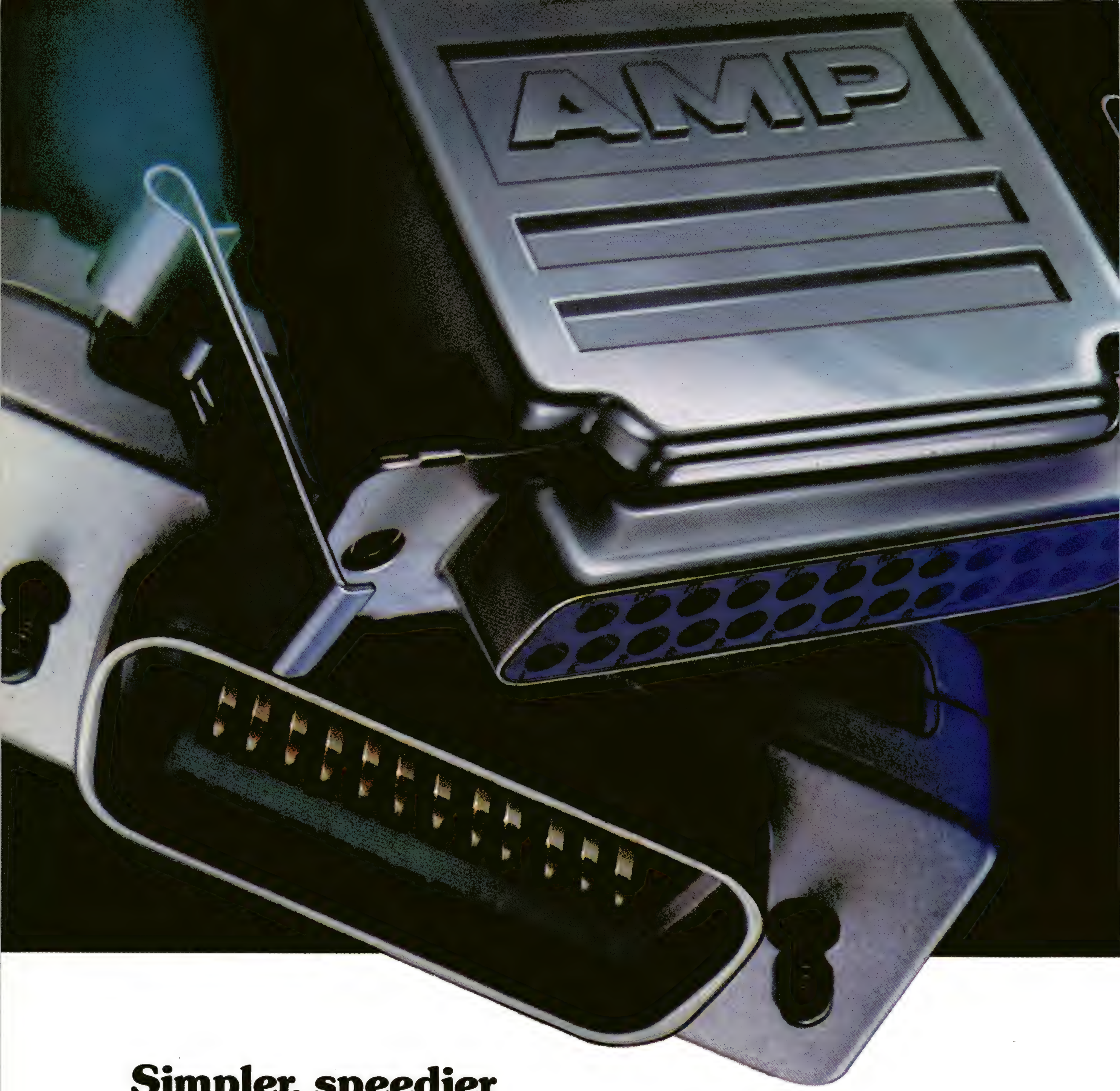
And the P30's innovative optical head and mechanical precision can only be Made in Switzerland.

EIE, ELECTRONIC INDUSTRIAL EQUIPMENT SA
P.O. Box 140
15, rue Marziano
CH-1211 Geneva 24
Switzerland

Tel: (022) 42 32 60
Tlx: 429 484 eie ch

PRIX DU
MÉRITE
INDUSTRIEL
DE LA VILLE
DE GENÈVE
1985

CIRCLE NO 83



Simpler, speedier shielded connectors—more new ways to put the clamp on EMI.

Peace and quiet, from AMP.

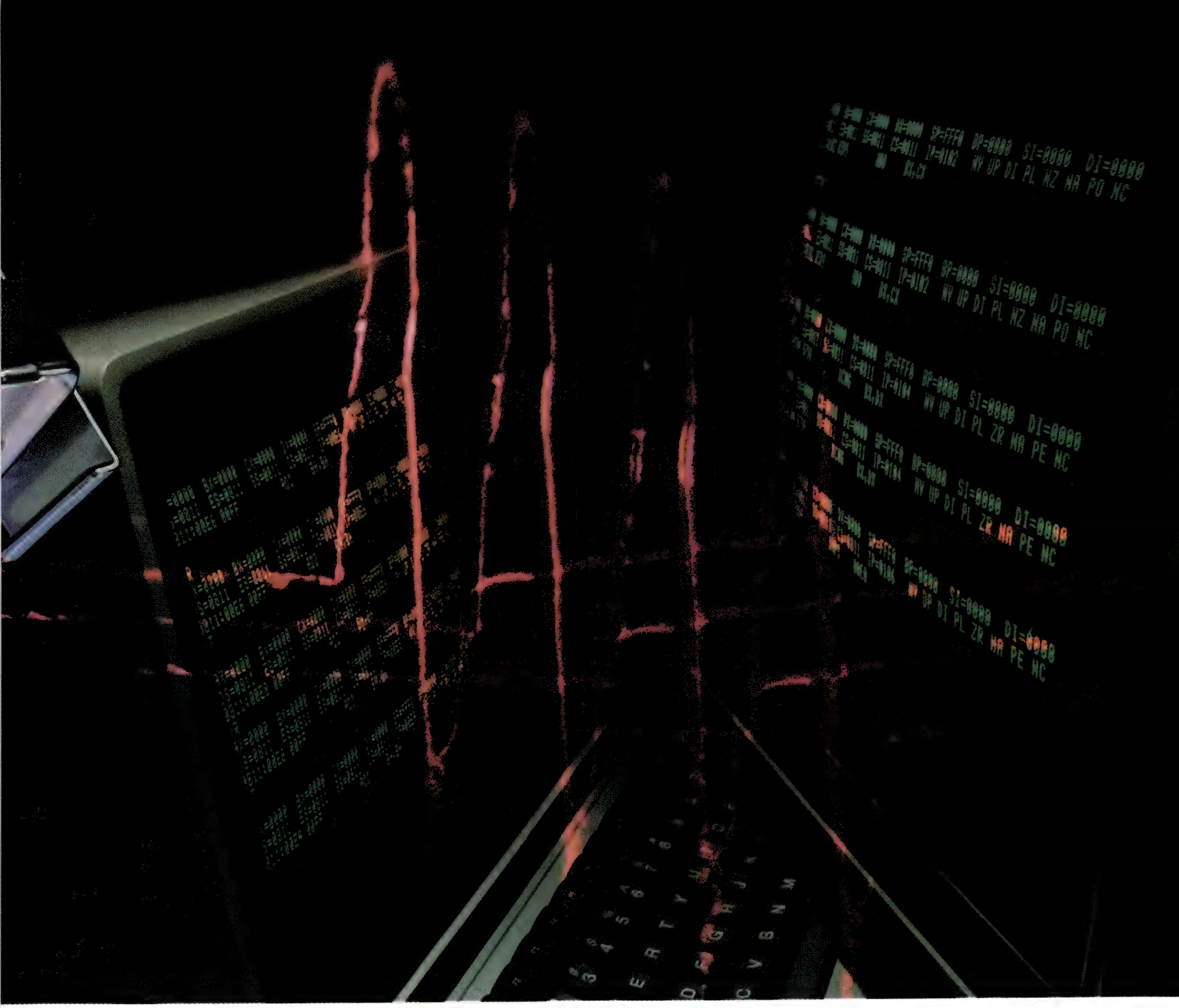
Strong medicine for EMI/ESD protection on a budget. AMP offers next-generation shielding solutions right now, lightweight, good-looking, and cost-effective.

Tired of bulky, bolted-down notions of shielding? We offer versions of our discrete-wire and ribbon-cable connectors with simple snap-together shields. They assemble in seconds, with far fewer parts to inventory.

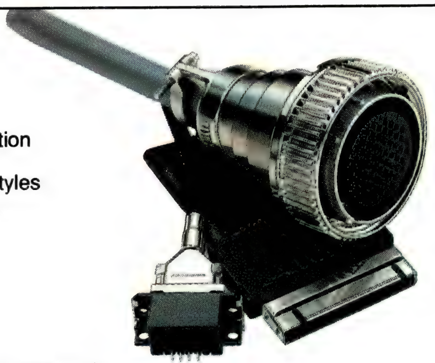
Can good looks and savings come together? We've got connectors with metal shielding on the inside, and—special note—connectors with metallized plastic shells: very light, very inexpensive, very practical. And still very attractive.

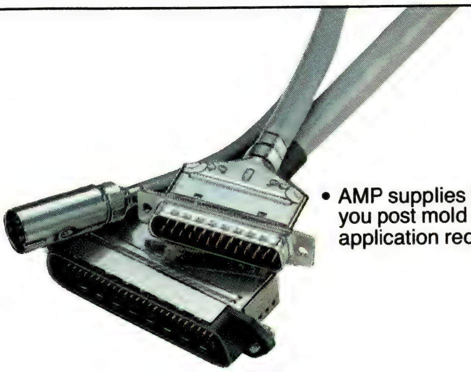
And we also offer shielded connectors for post-molding—a remarkably reasonable solution to your shielding problems if you're currently customizing your connectors.

After all, AMP has been making connectors simpler and easier to apply for a long time. It only stands to reason we'd have some ideas for EMC as well.



- A complete selection of pin/socket or post/receptacle styles
- Cable-to-cable or cable-to-board





- AMP supplies the shield, you post mold to your application requirements

Call (717) 780-4400 and ask for the AMP Shielded Connector Desk. AMP Incorporated, Harrisburg, PA 17105.

AMP Interconnecting ideas

AMP, AMPMODU, and AMP-LATCH are trademarks of AMP Incorporated.

CIRCLE NO 84

Only Mentor Graphics counts its blessings.

It sounds so simple.

You just acquire semicustom libraries, put them on a CAE workstation, and start cranking out designs.

No way.

In fact, there's an enormous effort that goes into assuring that a semicustom library is fully supported on a CAE system. An effort that requires extensive cooperation between IC and CAE vendors to ensure that both logic and physical versions of the library are "blessed" by both parties.

And only one CAE company has gone through this exercise so extensively for the libraries offered on its system.

Only Mentor Graphics.

We've worked diligently with IC vendors to assure that each logic library fully meets *their* requirements as well as ours. For instance, every part in each library is completely compatible with our IDEA Series™ schematic entry and simulation tools. You get accurate, consistent modeling of your design's logic behavior.

We've also done our homework on the physical libraries used by our automatic physical layout tools. Each is a highly accurate representation of the IC vendor's chip image, so our placement and routing tools are fine-tuned to operate in the vendor's specific physical environment. Which means they operate faster. With higher completion rates. So your products get to market quicker than ever.

Each library comes with a design kit fully endorsed by both Mentor Graphics and the IC vendor. One that carefully covers every aspect of the semicustom design process, from schematic entry to IC package definition. So you have a comprehensive guide on how to use our design automation tools during every step of semicustom IC development.

The result? No nasty surprises when your design moves from our CAE/CAD environment to the vendor's IC fabrication environment.

And when the layout is complete, you've got the completely automated back-annotation path necessary to include updated timing information back into your original design.

No other CAE vendor has matched the scope of our effort to produce blessed IC technology libraries. No one even comes close. Plus, there are a large number of additional qualified logic libraries to choose from, so you retain a high degree of latitude in selecting vendors and technologies.

And we're far from finished. Look for more semicustom IC design kits—gate array and standard cell—to become available for Mentor Graphics workstations on a regular basis.

It's all a part of a vision unique to Mentor Graphics, the leader in design automation. Let us show you where this vision can take you.

Call us for an overview brochure and the number of your nearest sales office.

Bracknell, England; Phone 0344-482828 **Livingston, Scotland;** Phone 0506-412222 **Munich, West Germany;** Phone 089-57096-0 **Wiesbaden, West Germany;** Phone 06121-371021 **Paris, France;** Phone 04-560-5151 **Milan, Italy;** Phone 02-824-4161 **Spanga, Sweden;** Phone 0468-750-5540 **The Hague, Netherlands;** Phone 070-624-461 **Tokyo, Japan;** Phone 03-589-2820 **Hong Kong;** Phone 0852-566-5113 **Singapore;** Phone 0779-1111 **Middle East, Far East, Asia, South America;** Phone 503-626-7000 **Mississauga, Ontario;** Phone 416-279-9060

Mentor Graphics™

IT'S AMAZING HOW LITTLE $100,000 BUYS A DESIGN GROUP.

To put this in perspective, let's begin with a couple of assumptions.

First, we'll assume that you're responsible for the activities of a design group consisting of a number of engineers. In addition, we'll assume your group is involved in a project of major proportions—one that requires several engineers to work simultaneously on sub-projects. Finally, we'll assume that you'd like to complete the project in the best, fastest, most cost-efficient manner.

With that $100,000 in your project budget, you could buy a single CAE workstation. Sure, it's powerful and sophisticated. But there's no getting around the fact that your engineers are going to have to wait in line to use it.

Now consider the alternative. With the same $100,000, you could buy five IBM AT's,® a MicroVAX II™ and Workview,™ the only IBM® PC-based software that addresses a design engineer's total workday needs—design, documentation and communications.

By opting for the

Viewlogic Systems, Inc., Marlboro, MA 01752. © 1986 Viewlogic Systems, Inc. All rights reserved. Viewlogic and Workview are registered trademarks of Viewlogic Systems, Inc.

IT'S AMAZING HOW MUCH $100,000 BUYS A DESIGN GROUP.

Visit us at Booth 957 at the Design Automation Conference in Las Vegas, June 29-July 2.

Workview solution, you give your engineers *on-demand access* to a powerful desktop CAE system. Instead of the common complaint that "my design's trapped," engineers have around-the-clock access to design facilities that include a schematics editor and an interactive simulator and fault grader with waveform I/O editing.

You also reduce the likelihood of errors in the product flow cycle. That's because Workview's documentation and communications facilities enhance the flow of design data between departments.

And if you're concerned that Workview may invalidate your investment in hardware, symbols libraries, training and so on, you needn't be. Workview is compatible with most existing engineering environments. It has to be. They came first.

For more information, call us toll-free at 1-800-CAE-VIEW. In MA, the number is 617-480-0881.

VIEWlogic®

IBM and IBM Personal Computer AT are registered trademarks of International Business Machines Corporation. MicroVAX II is a trademark of Digital Equipment Corporation.

CIRCLE NO 85

Software packages for standard 32-bit CAE/ CAD workstations

CAE-software vendors are switching from selling proprietary packages to offering their software for the de facto standards among 32-bit workstations. Because these machines run a wide variety of CAE and CAD programs, you can use a single 32-bit workstation for all your CAE tasks.

Eva Freeman, *Associate Editor*

You no longer need to maintain an assortment of workstations for electronic design. Instead of using CAE workstations that require proprietary operating systems and run only their vendors' own software, you can run a wide variety of software packages on one of the 32-bit CAE workstations that have become de facto standards: the Domain from Apollo Computer Inc (Chelmsford, MA), the MicroVAX II-based workstations from Digital Equipment Corp (Maynard, MA), and the Sun-3 from Sun Microsystems Inc (Mountain View, CA) (see **box,** "Standard 32-bit CAE workstations," pg 138). Third-party software companies are also porting their products to two other workstations that are on their way to becoming standards: The 9000 Series 320 from Hewlett-Packard (Palo Alto, CA) and the RT PC from IBM (Rye Brook, NY), both of which were introduced recently.

Integrated CAE/CAD packages

A number of CAE-software companies are offering integrated software packages—which generally provide at least schematic capture, logic simulation, and net-list generation—for the standard 32-bit machines. (See **Table 1** on pg 144 for a comparison of the electronic-design-automation packages that run on the 32-bit workstations from Apollo, DEC, Sun, and Hewlett-Packard.) Valid Logic Systems, for instance, ports its software to DEC's VAXstation II. This month, the company is introducing two turnkey (hardware/software) packages. One package comprises the company's CAE software and a VAXstation II monochrome workstation; the other combines the software with a VAXstation II/GPX color workstation. The packages let you enter schematic drawings, simulate logic, verify timing, and create net lists. They also allow you to access the company's application-specific hardware, which consists of hardware modelers and simulation accelerators. The VAXstation II and VAXstation II/GPX turnkey systems cost $79,000 and $89,000, respectively.

In addition to offering these CAE packages, Valid has a $120,000 pc-board-CAD package for the MicroVAX II computer. The system, Board Designer, consists of automatic-placement-and-routing software, the MicroVAX II computer, and the company's own graphics terminal.

Also offering ports of its software for the VAXstation II/GPX is Case Technology, which introduced its $11,900 CT4000 software for the VAXstation II last October. This month the company is offering a port of the same CAE package for the VAXstation II/GPX. Besides providing schematic capture and logic simulation, the program lets you lay out pc boards on the VAXstation II/GPX. This month, the com-

A variety of CAE software packages *now play on standard workstations. (Photo courtesy Mentor Graphics)* pany expects to offer an extension of this package; the extension will provide automatic routing for pc boards.

Two other CAE/CAD firms, Computervision and Applicon, port their software to workstations based on the Sun system, which adheres to such standards as Berkeley Unix 4.2 and Ethernet TCP/IP. Both Computervision and Applicon modify the Sun system in house; their systems abide by the same hardware and software standards that Sun's workstations do. The companies' software doesn't run on unmodified Sun workstations. However, third-party software written for Sun workstations does run on Computervision's and Applicon's modified workstations.

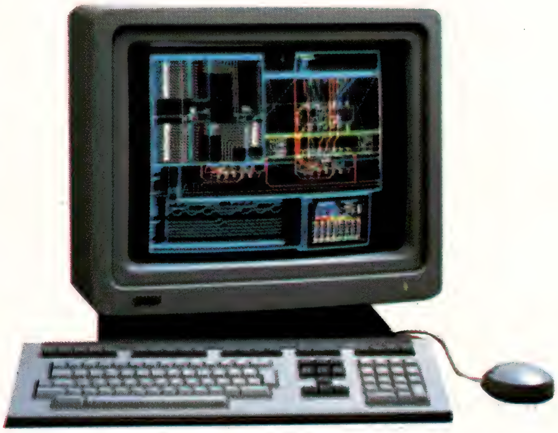
Computervision's Sun-based workstation includes two 85M-byte hard-disk drives and a proprietary graphics-accelerator board. The company's CADDS pc-board layout package runs under the Sun operating system. Its design database maintains compatibility with Computervision's other CADDS-4X systems, which run on Computervision's proprietary hardware.

The CADDS package features the company's Autoboard autorouter. Instead of following the rip-and-reroute approach of many pc-board routers, this $81,000 package repositions traces, a method that minimizes the length of board routes. To develop a pc-board routing pattern, the automatic router uses six routing algorithms successively: straight lines, orthogonal bends, single vias, via pairs, pin-to-pin connections, and signal-to-signal connections.

Applicon, whose Bravo PCB pc-board layout software runs on MicroVAX II workstations, is now introducing the Bravo III package for its Sun-based work-

To speed the logic and fault simulation *performed by the Cadat package from HHB Systems, you can add the company's hardware accelerator and hardware modeler to your 32-bit workstation. Besides operating with Sun systems (as shown), the package interfaces to Apollo and MicroVAX II workstations.*

Because its software integrates schematic capture, layout, *simulation, and test development, GE Calma can turn an Apollo 3000 workstation into a complete pc-board development system.*



This pc-board design package *is one of Hewlett-Packard's DesignCenter programs, which run on HP 9000 Series 320 workstations and share a compatible database structure. Other DesignCenter programs offer schematic capture, logic simulation, analog design, software development, and mechanical design.*

You can find a number of general-purpose logic simulators that run on all five of the standard workstations as well as a number of other systems.

stations. The software encompasses electrical and mechanical design as well as CAE functions.

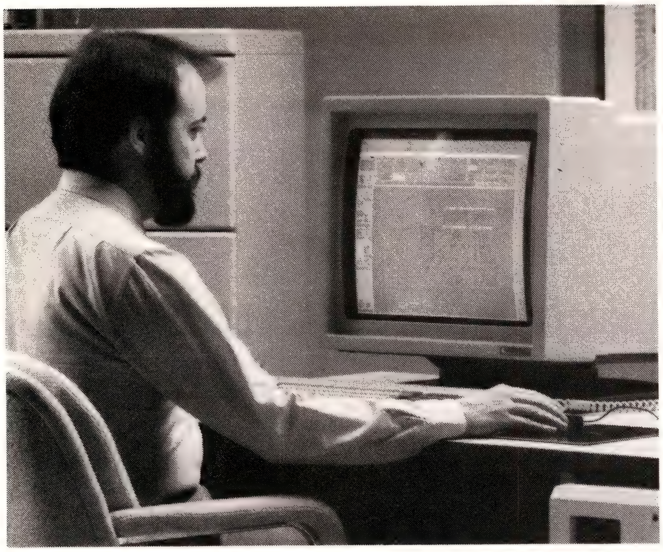
You can also find integrated CAE packages for Apollo workstations. Mentor, whose CAE software runs on the Apollo machines, is expanding the capabilities of its VLSI-design software package, Chip Station. Remedi, which Mentor is introducing this month, is an optional enhancement of Chip Station that lets you verify IC layouts. The VLSI-layout verifier can display color-coded layout matches or mismatches on a workstation's screen.

You can interface Remedi to the company's other design packages; by using Remedi to extract parastic capacitances from a layout created with Chip Station, you can back-annotate your schematics from the other design packages. Remedi, which integrates Calma's GDS II design format and Ecad's Dracula layout verifier in Mentor's CAD software, costs about $15,000.

An integrated package for Hewlett-Packard's 9000 Series 320 workstation comprises several third-party programs. The company's DesignCenter programs share a compatible database structure. Until this month, the company offered only the Design Capture System schematic-capture package and GenRad's Hilo-3 logic and fault simulator for its workstation.

Hewlett-Packard is now expanding DesignCenter to include GenRad's HiChip hardware-modeling system; the Printed Circuit Design System, which is based on the CBDS pc-board layout package from Bell Northern Research (Ottawa, Ontario); the Analog Workbench analog-circuit design package from Analog Design Tools; and the Teamwork/SA computer-aided software-

***Running on both VAXstation II workstations and VAX minicomputers,** the CT4000 design and layout package from Case Technology lets you design pc boards interactively on a workstation and use the greater computational power of a minicomputer for automatic routing.*



You can easily transfer your database to a workstation *when you use CADDS-4X pc-board layout software from Computervision; the company's Sun-based workstation shares a common database with Computervision's existing systems.*

engineering program from Cadre Technology (Providence, RI). HiChip costs $39,000, and Teamwork/SA lists for $8500. The Printed Circuit Design System comes with the 9000 Series 320 workstation and costs $60,000 to $82,000.

Multiple ports of CAE/CAD packages abound

The third-party packages that run on Hewlett-Packard's CAE workstations also run on other 32-bit workstations. For example, you can run the Analog Workbench on Sun and Apollo systems, and you can even

Standard 32-bit CAE workstations

In the past year, three 32-bit workstations have become de facto standards for electronics CAE and CAD. The MicroVAX II-based workstations from DEC, the Domain machines from Apollo, and the Sun-3 workstation from Sun Microsystems began to become standards for CAE when a number of other CAE firms discontinued the production of their own workstations and began to offer software for these workstations.

Apollo and Sun each offer a range of workstations, so they let you choose from a variety of graphics features and memory options. DEC doesn't offer as many models of workstations, but because its MicroVAX II workstation is compatible with its VAX computers, it effectively provides more processing power for your tasks. Two other workstations, the Hewlett-Packard 9000 Series 320 and the IBM RT PC, are also becoming de facto standards; a number of companies are already porting their software to these machines.

The variety of available software isn't the only advantage of standard workstations. The manufacturers of these workstations also offer you add-in boards. And because they specialize in hardware, manufacturers of standard workstations can provide better repair services than can firms that produce both proprietary hardware and software.

Because you'll be able to choose from a wide range of software for these standard machines, the software available for a particular machine no longer has to be your first consideration when you choose a system. Instead, you'll want to consider a machine's CPU speed, display size, display resolution, maximum memory size, bus, networking capabilities, operating systems, and, of course, price.

You can use the information in **Tables 2** and **3** on pg 148 and to compare similar 32-bit workstations from Apollo, DEC, HP, IBM, and Sun. **Table 2** contains a sampling of monochrome systems; **Table 3** lists color workstations. Both tables compare systems that contain only the minimum memory configurations available, but feature high-resolution screens. All the systems listed include hard-disk and cartridge-tape drives.

If you're looking for a large selection of color workstations, consider machines from Apollo, which offers three systems: the 3000, DN570, and DN580. The DN570 costs $41,800 with hard-disk and cartridge-tape drives. In addition to the features of the DN570, the DN580 provides 3-D graphics software; it costs $52,800.

Monochrome workstations are Sun's forte. Like Apollo, the company offers a lineup of five monochrome models, including a diskless node that starts at $7900 and a gray-scale system that costs $29,900.

Instead of offering a range of workstation models, as Apollo and Sun do, DEC offers only one color and two black-and-white VAXstation II workstations. However, the company's MicroVAX II-based workstations are compatible with its VAX minicomputers, so by downloading certain tasks from a MicroVAX II workstation to a VAX, you can obtain a lot of extra processing power for your CAE tasks. Although the MicroVAX

Because they specialize in hardware, manufacturers of standard workstations can offer you add-in boards and repair services for their machines.

interface the package to Mentor's CAE database. IBM licenses CBDS and ports the layout software to its mainframes; Documented Circuits (Kingston, Ontario) sells a slightly different version of the same program for the VAX.

General-purpose logic simulators

You can find a number of general-purpose logic simulators that run on all five of the standard workstations as well as a number of other systems. GenRad's Hilo-3, for instance, runs on systems ranging from personal computers to mainframes. Besides running on HP's workstations, the program runs on the Apollo, Sun, and DEC workstations. GenRad recently introduced a port of Hilo-3 to the IBM RT PC.

Gateway Design Automation's general-purpose simulators also run on the three standard 32-bit workstations and a number of other machines. Bitgrade, which the company unveils this month, grades test patterns for self-testing digital circuits. Although you can use a standard fault simulator for self-testing circuits, this specialized tool evaluates the coverage of a

Text continued on pg 142

II's operating system, MicroVMS, isn't exactly like the VAX's operating system, VMS, the distinctions between the two operating systems rarely affect application programs (see "CAE software packages adapt easily to the MicroVAX II 32-bit computer," EDN, November 28, 1985, pg 61). In general, a program that runs on the VAX also runs on the VAXstation II.

The VAXstation II/RC, which DEC is introducing this month, brings the price of a workstation into the high-performance personal-computer range. The $14,995 base price of this monochrome system includes the operating system, LAN interface software, a floating-point coprocessor, a 71M-byte hard-disk drive, and a 95M-byte cartridge-tape drive. The VAXstation II/RC differs from the $29,640 VAXstation II only in its lack of a system bus, which you'd use to add expansion boards such as RAM cards. If you need additional memory for your VAXstation II/RC, you have to transfer your files to another MicroVAX II-based system or to a VAX.

Unlike the other 32-bit workstations, the IBM RT PC uses a reduced-instruction-set-computer (RISC) architecture. A RISC's instruction set consists almost exclusively of instructions that the computer can execute in one machine cycle. For the RT PC, that machine cycle is about 170 nsec.

This 170-nsec machine cycle is the same as a 5.9-MHz clock frequency; however, because the RISC architecture rarely uses multistep instructions, the overall speed of the RISC µP is comparable to that of the 68020 or the MicroVAX II µP. In general, a RISC µP can execute instructions in about half the time a standard microprocessor requires, so the RISC µP operates at a speed roughly equal to that of a conventional µP operating at 11.8 MHz.

Standard operating systems

As you might expect, the trend toward standard 32-bit workstations is causing a trend toward standard operating systems. For instance, the companies that base their systems on Motorola's MC68020 µP—Apollo, Sun, and Hewlett-Packard—are using Unix-based operating systems. Unix is, in fact, the most widely used operating system for technical workstations. However, although every computer vendor offers Unix, each offers a different implementation of Unix.

According to Apollo, its Domain/IX version of Unix is the only twin port of Berkeley Unix 4.2 and AT&T Unix System V. The IBM RT PC's AIX operating system combines AT&T Unix V and Berkeley Unix 4.2 with IBM's own enhancements. Hewlett-Packard uses just AT&T Unix V in its HP-UX, but adds proprietary features such as windowing and a symbolic debugger. DEC, on the other hand, bases the Ultrix-32m operating system for its MicroVAX II-based systems only on Berkeley Unix 4.2. Sun, which also uses Berkeley Unix 4.2 for its Sun Unix operating system, claims that its implementation conforms most strictly to Berkeley's Unix.

Vendors of CAE/CAD software for 32-bit workstations

For more information on CAE or CAD software packages that run on 32-bit workstations, circle the appropriate numbers on the Information Retrieval Service card or contact the following manufacturers directly.

AB Associates
Box 82215
Tampa, FL 33682
(813) 932-9853
Circle No 600

Academi Systems Inc
200 Brown Rd
Fremont, CA 94539
(415) 659-0105
Circle No 601

AEG Telefunken Software-Technik
Goldsteinstrasse 235
D-6000 Frankfurt 71, West Germany
069-6679-297
Circle No 602

Aida Corp
3375 Scott Blvd
Santa Clara, CA 95054
(408) 748-8571
Circle No 603

Analog Design Tools Inc
66 Willow Pl
Menlo Park, CA 94025
(415) 328-0780
Circle No 604

A O Smith Data Systems
8901 N Kildeer Ct
Milwaukee, WI 53209
(800) 558-6980
Circle No 605

Applicon
4251 Plymouth Rd
Ann Arbor, MI 48106
(313) 995-6000
Circle No 606

Apsis
Chemin du Vieux Chêne
Meylan, France 38240
(76) 90-20-03
Circle No 607

Assigraph
72 Quai de Carrières
94227 Charenton-Le-Pont, France
33(1)4-375-92-92
Circle No 608

Berne Electronics Inc
1509 Betts NE
Albuquerque, NM 87112
(505) 293-3611
Circle No 609

Cade GmbH
Hirschstrasse 98
D-7903 Laichingen, West Germany
(4907) 333-6069
Circle No 610

Cadmatics
21907 San Miguel St
Woodland Hills, CA 91364
(818) 884-8957
Circle No 611

Cadnetix Corp
5757 Central Ave
Boulder, CO 80301
(303) 444-8075
Circle No 612

Caeco
1160 S State St
Orem, UT 84058
(801) 226-6509
Circle No 613

Caedent Corp
6760 Corporate Dr
Colorado Springs, CO 80919
(303) 548-1000
Circle No 614

Case Technology Inc
633 Menlo Ave
Menlo Park, CA 94025
(415) 322-4057
Circle No 615

Clarity Systems Inc
710 Lakeway Dr
Sunnyvale, CA 94086
(408) 730-1381
Circle No 616

Communications Consulting Corp
483 McLean Blvd
Paterson, NJ 07504
(201) 881-1200
Circle No 617

Computervision Corp
100 Crosby Dr
Bedford, MA 01730
(617) 275-1800
Circle No 618

Control Data Corp
Box 0
Minneapolis, MN 55440
Phone local office
Circle No 619

Daisy Systems Corp
700 Middlefield Rd
Mountain View, CA 94039
(415) 960-0123
Circle No 620

Data I/O Corp
Box 97046
Redmond, WA 98073
(206) 881-6444
Circle No 621

Decad SA
ZI Les Bruyères av Le Verrier
78190 Trappes, France
(331) 30-62-81-65
Circle No 622

Digsim System AB
Box 10004
S-580 10 Linkoping, Sweden
(013) 17-50-40
Circle No 623

Ecad Inc
2455 Augustine Dr
Santa Clara, CA 95054
(408) 727-0264
Circle No 624

Eesof Inc
31194 La Baya Dr
Westlake Village, CA 91362
(818) 991-7530
Circle No 625

Electrical Engineering Software
4675 Stevens Creek Blvd
Santa Clara, CA 95051
(408) 296-8151
Circle No 626

Electrocon International Inc
611 Church St
Ann Arbor, MI 48104
(313) 761-8612
Circle No 627

Electronic Software Products Inc
130 McCormick Ave
Costa Mesa, CA 92626
(714) 966-1777
Circle No 628

Endot Inc
11001 Cedar Ave
Cleveland, OH 44106
(216) 229-8900
Circle No 629

Factron
269 Mount Hermon Rd
Scotts Valley, CA 95066
(408) 438-2880
Circle No 630

Gateway Design Automation Corp
Box 1545
Littleton, MA 01460
(617) 486-9701
Circle No 631

GE Calma
501 Sycamore Dr
Milpitas, CA 95035
(408) 434-4000
Circle No 632

GenRad Inc
510 Cottonwood Dr
Milpitas, CA 95035
(408) 946-6960
Circle No 633

Grumman Aerospace Corp
ATE Systems Dept
Bethpage, NY 11714
(516) 575-7861
Circle No 634

Hewlett-Packard Co
1820 Embarcadero Rd
Palo Alto, CA 94303
Phone local office
Circle No 635

HHB Systems
1000 Wyckoff Ave
Mahwah, NJ 07430
(201) 848-8000
Circle No 636

Image Acoustics Inc
Box 6
North Marshfield, MA 02059
(617) 834-6376
Circle No 637

Infolytica Corp
1500 Stanley St
Montréal, Québec H3A 1R3
(514) 849-8752
Circle No 638

Integrated Measurement Systems Inc
9525 SW Gemini Dr
Beaverton, OR 97005
(503) 626-7117
Circle No 639

Intercad Corp
2525 Riva Rd
Annapolis, MD 21401
(301) 224-2926
Circle No 640

Intergraph Corp
1 Madison Industrial Park
Huntsville, AL 35807
(205) 772-2000
Circle No 641

Jensen Transformers Inc
10735 Burbank Blvd
North Hollywood, CA 91601
(213) 876-0059
Circle No 642

Lattice Logic Ltd
9 Wemyss Pl
Edinburgh EH3 6DH, Scotland
031-225-3434
Circle No 643

Logic Automation Inc
19545 NW Von Neumann Dr
Beaverton, OR 97075
(503) 690-6900
Circle No 644

LSI Logic Corp
1551 McCarthy Blvd
Milpitas, CA 95035
(408) 263-9494
Circle No 645

Lucasfilm Ltd
Box CS 8180
San Rafael, CA 94912
(415) 485-5000
Circle No 646

Management Sciences Inc
6022 Constitution Ave NE
Albuquerque, NM 87110
(505) 255-8611
Circle No 647

Mentor Graphics Corp
8500 SW Creekside Pl
Beaverton, OR 97005
(503) 627-7000
Circle No 648

Meta-Software Inc
50 Curtner Ave
Campbell, CA 95008
(408) 371-5100
Circle No 649

Mirashanta
Box 3000
Camarillo, CA 93011
Circle No 650

Mosaid Inc
Box 13579
Kanata, Ontario K2K 1X6 Canada
(613) 836-3134
Circle No 651

Omnicad Corp
1000 Pittsford-Victor Rd
Pittsford, NY 14534
(716) 385-8500
Circle No 652

Optima Technology Inc
900 Middlesex Tpk
Billerica, MA 01821
(617) 667-7877
Circle No 653

Orcatech Inc
28 Steacie Dr
Kanata, Ontario K2K 2A9 Canada
(613) 592-7650
Circle No 654

Pacific Numerix Corp
4180 La Jolla Village Dr
La Jolla, CA 92037
(619) 587-0500
Circle No 655

Personal CAD Systems Inc
2790 Parkmore Ave
San Jose, CA 95126
(408) 971-1300
Circle No 656

Phoenix Data Systems Inc
2700 Augustine Dr
Santa Clara, CA 95054
(408) 988-8804
Circle No 657

Quantic Laboratories Inc
222 Osborne St
Winnipeg, Manitoba R3L 1Z3 Canada
(204) 474-0020
Circle No 658

Racal-Redac Inc
4 Lyberty Way
Westford, MA 01886
(617) 692-4900
Circle No 659

RCA Advanced Technology Laboratory
Rte 38
Moorestown, NJ 08507
(609) 866-6425
Circle No 660

Scientific Calculations Inc
7635 Main St
Fishers, NY 14453
(716) 385-6790
Circle No 661

SDA Systems
2461 Mission College Blvd
Santa Clara, CA 95054
(408) 727-7811
Circle No 662

Seattle Silicon Technology Inc
12356 Northrup Way
Bellevue, WA 98005
(206) 883-2176
Circle No 663

Sherpa Corp
2355 Old Oakland Rd
San Jose, CA 95131
(408) 942-1535
Circle No 664

Shiva Multisystems Corp
1040 Marsh Rd
Menlo Park, CA 94025
(415) 321-2350
Circle No 665

Silicon Compilers Inc
2045 Hamilton Ave
San Jose, CA 95125
(408) 371-2900
Circle No 666

Silicon Design Labs Inc
Box 16
Liberty Corner, NJ 07938
(201) 580-0102
Circle No 667

Silvaco Data Systems
2328 Walsh Ave
Santa Clara, CA 95051
(408) 988-2862
Circle No 668

Silvar-Lisco
1080 Marsh Rd
Menlo Park, CA 94025
(415) 324-0700
Circle No 669

SimuCad
Box 3400
Incline Village, NV 89450
(702) 831-1399
Circle No 670

Staveley Computing
Blackpole Rd
Worcester WR3 8TH, England
(0905) 53335
Circle No 671

Syscon Corp
540 Weddell Dr
Sunnyvale, CA 94089
(408) 734-4910
Circle No 672

Systems Control Technology Inc
1801 Page Mill Rd
Palo Alto, CA 94303
(415) 494-2233
Circle No 673

Technical Software Systems
Box 2525
Livermore, CA 944550
(415) 443-7213
Circle No 674

Technology Modeling Associates Inc
445 Burgess Dr
Menlo Park, CA 94025
(415) 327-6300
Circle No 675

Tektronix Inc
5302 Betsy Ross Dr
Santa Clara, CA 95054
(408) 727-1234
Circle No 676

Telesis Systems Corp
2 Omni Way
Chelmsford, MA 01824
(617) 256-2300
Circle No 677

Teradyne Inc
321 Harrison Ave
Boston, MA 02118
(617) 482-2700
Circle No 678

Texas Instruments Ltd
Manton Lane
Bedford, England
(44) 234-67466
Circle No 679

Thomson Informatique Services
104 Rue Castagnary
75015 Paris, France
(1) 531-16-80
Circle No 680

Valid Logic Systems Inc
2820 Orchard Parkway
San Jose, CA 95134
(408) 945-9400
Circle No 681

Vectron Graphics Systems Inc
4401 Great America Parkway
Santa Clara, CA 95054
(408) 980-1180
Circle No 682

Via Systems Inc
76 Treble Cove Rd
N Billerica, MA 01862
(617) 667-8574
Circle No 683

VLSI Technology Inc
1109 McKay Dr
San Jose, CA 95131
(408) 942-1810
Circle No 684

Xerox Corp
2710 Walsh Ave
Santa Clara, CA 95051
(408) 988-2800
Circle No 685

Zymos
477 N Mathilda Ave
Sunnyvale, CA 94086
(408) 730-5400
Circle No 686

Because of the variety of CAE/CAD tools available for the standard workstations, you can design entire systems on these workstations.

set of test vectors more quickly by several orders of magnitude than a standard fault simulator can.

Gateway's Bitgrade fault simulator breaks self-testing circuits into blocks of combinatorial logic and response-accumulation logic. The software then uses proprietary algorithms to rapidly simulate faults in the combinatorial logic. In addition to simulation algorithms, the package includes a circuit-description language that's intended specifically for creating self-testing circuits. Prices for Bitgrade start at $25,000.

Data-management software untangles projects

Because of the variety of CAE/CAD tools available for the standard 32-bit workstations, you can design entire systems on these workstations. Such design projects, which require teams of engineers, also require data management. For such a task, you could use a data-management system like Sherpa's DMS. The package, which runs on MicroVAX II workstations, automatically tracks and controls design databases.

The VAX-based DMS package documents the identity, origin, level, authorized users, and history of each file in a project. Because the package can identify the status of each file, it can control access privileges to engineering data and enforce adherence to correct design methodology. The program only controls files; it doesn't affect their contents. You can buy this software for $50,000 to $80,000, depending on the host computer you use.

Tektronix uses a modified implementation of DMS in its Team Engineering software, which is a standard feature of every member of the company's WorkSystem family of CAE and CAD tools. Tektronix, which strongly endorses the concept of hardware standards, has discontinued its own CAE/CAD workstations; it now offers software for MicroVAX II and Apollo workstations. WorkSystem products start at $20,000 (for the Designer's WorkSystem CAE package).

Standardization in software lies ahead

In the next year, you're likely to see the same trend toward standardization in CAE software that you see this year in CAE hardware. In fact, this trend toward standardization is already beginning. A number of integrated CAE and CAD packages now incorporate applications programs from companies that specialize in particular CAE-software areas. For example, GE Calma and Tektronix CAE Systems both incorporate OmniCAD's autorouting software in their integrated pc-board CAD systems; Valid and Silvar-Lisco both license Optima's autorouting package. Other CAD vendors are indicating that they will soon switch from their own autorouters to third-party products.

This pc-board design and layout package, *the Visula package from Racal-Redac, runs both on Apollo workstations, such as this Domain Series 3000 machine, and on MicroVAX II-based workstations.*

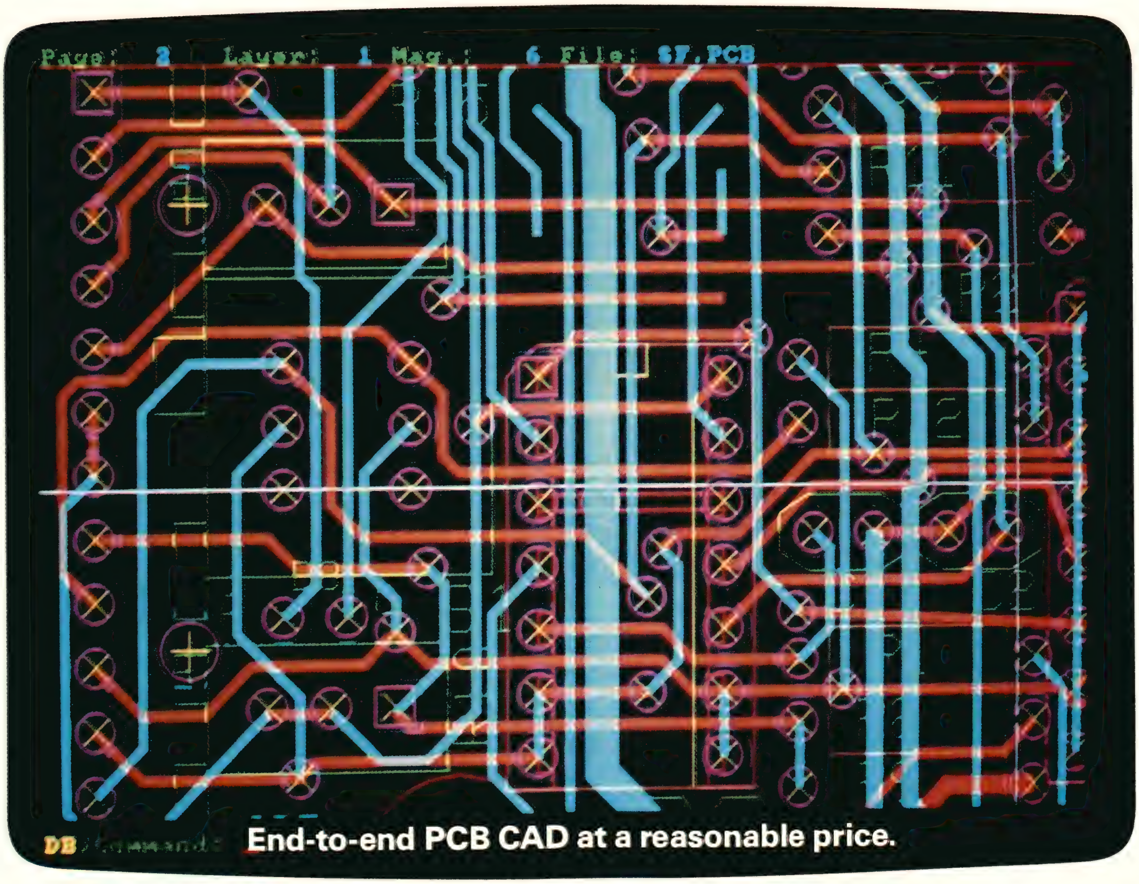
In addition, many CAD companies are already seeking to incorporate silicon compilers in their integrated IC-design packages. For example, Mentor, Valid, and Tektronix include the Concorde package from Seattle Silicon in their packages, and Daisy and Mentor both offer Silicon Compilers' Genesil package as part of their integrated CAD packages. **EDN**

References

1. Foundyller, Charles, *CAD/CAM, CAE: Survey, Review, and Buyers' Guide*, Daratech, Cambridge, MA, 1986. $428.
2. *Catalogue of Applications for Domain Systems—Summary*, Apollo Computer Inc, Chelmsford, MA, 1986.
3. *Referral Catalog for Computer-Aided Engineering and Manufacturing, Third Edition*, Digital Equipment Corp, Marlborough, MA, 1985.
4. *Catalyst*, Sun Microsystems Inc, Mountain View, CA, 1986.
5. *Technical Software Catalog*, Hewlett-Packard Co, Fort Collins, CO, 1985.
6. Freeman, Eva, "Computer-aided engineering/design workstations," *EDN*, May 30, 1985, pg 141.

Article Interest Quotient (Circle One)
High 470 Medium 471 Low 472

You knew it was bound to happen.



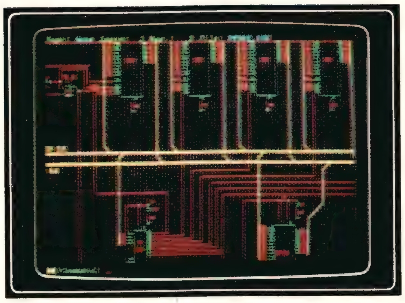
End-to-end PCB CAD at a reasonable price.

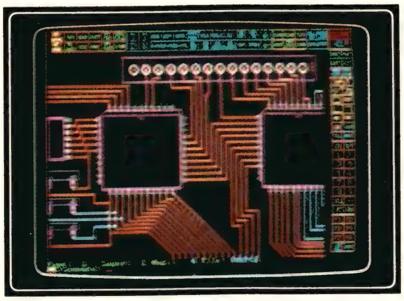
It's the first rule of electronics: Function goes up and price comes down. Now, Aptos gives you big system design tools at small system prices.

The AT Powerstation. One engineer, one workstation. That's the objective. Aptos makes it affordable. Schematic and PCB layout design, library management, logic simulation with nine states, plotter outputs, you name it. All on a PC-AT.

The money machine. The Aptos system is so powerful that it's easy to learn and use. Which means you'll be designing better boards faster. Nobody needs to tell you that time is money.

Horsepucky? We'll put our money where our mouth is. If you're thinking about a PCB CAD system, call us. We'll come running with the Aptos System. Benchmark us against those guys who say they want to be the "benchmark," or, against the big guys who want to sell you a crippled system now, and their real system later. We'll give you a hands-on demonstration of the Aptos System... and let the chips fall where they may.





Just getting your toes in the water? Swell. Circle our Reader Service Card number. We'll send you an informative booklet: **"How to Buy CAD/CAE for Personal Computers."** Free. Or send us your check or P.O. for $25 (refundable with your first purchase). We'll send you our VCR tape, "How to buy CAD/CAE." Make your own comparisons. Then call us for a free demonstration. Your place or ours.

APTOS SYSTEMS

Aptos Systems Corporation
4113 Scotts Valley Road
Scotts Valley, CA 95066 USA
Phone: Collect (408) 438-2199
TELEX: 3710387 APTOS SYS

In the U.K., Telex Chiptech: 267107 CHIPALG • In France, Telex Tekelec Airtronic: 204552 TKLEC • In Italy, Telex Electronucleonica: 332033 NUCLEO I • In Asia, Telex SPI: 4997020 SPIUS

CIRCLE NO 86

TABLE 1—CAE SOFTWARE FOR 32-BIT WORKSTATIONS

COMPANY	PROGRAM	WORKSTATION				FUNCTION							COMMENTS
		APOLLO DOMAIN	DEC VAXSTATION II	HEWLETT-PACKARD 9000 SERIES 320	SUN MICROSYSTEMS SUN-3	SCHEMATIC CAPTURE	LOGIC SIMULATION	CIRCUIT SIMULATION	FAULT SIMULATION	IC LAYOUT	IC-LAYOUT VERIFICATION	PC-BOARD LAYOUT	
AB ASSOCIATES	I-G SPICE	•	•					•					INTERACTIVE GRAPHICS
ACADEMI	SOLUTION		•									•	MULTILAYER ROUTER
AEG-TELEFUNKEN	RUPLAN	•				•							DATABASE FILES
AIDA	DESIGN SYSTEM	•				•	•		•				ACCELERATED SIMULATOR
ANALOG DESIGN	ANALOG WORKBENCH	•		•	•	•		•					SIMULATED INSTRUMENTS
AO SMITH	ELECTROMAG	•											ELECTROMAGNETIC FIELDS
APPLICON	BRAVO III		•		•	•	•		•			•	MECHANICAL ENGINEERING
APSIS	ELDO	•						•					MIXED MODES
ASSIGRAPH	SAFIRS		•		•	•							ELECTRICAL INSTALLATIONS
BERNE	ELAN		•					•					RELIABILITY ANALYSIS
CADE	CADES-G		•			•						•	FOUR AUTOROUTERS
CADMATICS	LDAT		•			•							WIRE-WRAP BOARDS
CAECO	VLSI DESIGNER	•			•	•				•	•		INTERACTIVE DESIGN-RULE CHECK
CAEDENT	INTELLITEST		•						•				STATISTICAL ANALYSIS
CASE	CT4000		•			•	•	•	•			•	IBM PC COMPATIBLE
CLARITY	SUPERSET	•				•				•	•		SYMBOLIC LAYOUT
COMMUNICATIONS	SUPERCOMPACT	•	•	•				•		•			MICROWAVE DESIGN
COMPUTERVISION	CADDS				•	•	•		•			•	MOVES BOARD TRACES
CONTROL DATA	ELECTRONICS DESIGNER		•			•	•	•	•			•	TIMESHARING AVAILABLE
DAISY	LOGICIAN VX		•			•	•	•					SERVER FOR PCs
DATA I/O	ABEL	•	•		•		•						PLD SIMULATOR
DECAD	DEDALE	•			•							•	12 LOGIC LAYERS
DIGSIM	DIGSIM		•				•						GRAPHICS DISPLAY
ECAD	DRACULA	•	•		•			•			•		MASK GENERATOR
EESOF	TOUCHSTONE	•		•				•					MICROWAVE DESIGN
EE SOFTWARE	PRECISE	•	•		•			•					INTERACTIVE SIMULATOR
ELECTROCON	GUN3D	•											ELECTRON-GUN DESIGN
ENDOT	N.2	•	•	•	•		•						SYSTEM SIMULATOR
ESP	USPICE		•					•					TRANSIENT CONVERGENCE
FACTRON	ESP		•			•	•	•	•	•	•		IBM PC COMPATIBLE
GATEWAY	AIDSSIM	•	•		•		•		•				SELF-TESTING CIRCUITS
GE CALMA	T-BOARDS	•	•			•	•	•	•	•		•	ASIC DESIGN
GENRAD	HILO-3	•	•	•	•		•		•				TEST GENERATOR
GRUMMAN	LOGOS III		•						•				TEST PROGRAM
HHB	CADAT	•	•		•		•		•				BEHAVIORAL MODELING
IMAGE	DI			•									ANTENNA ANALYSIS
INFOLYTICA	MAG NET			•	•								ELECTROMAGNETIC ANALYSIS
INTERCAD	SCS	•				•							BILL OF MATERIALS
INTERGRAPH	TANCELL		•							•	•		SEMICUSTOM LAYOUT
JENSEN	COMTRAN			•				•					WAVEFORM ANALYSIS
LATTICE	CHIPSMITH	•	•		•	•	•			•	•		SILICON COMPILER
LOGIC AUTOMATION	SMARTPARTS	•					•						μP MODELS
LSI LOGIC	MACGEN	•	•		•	•	•		•				ASIC DESIGN

Table continued on pg 146

ArrowAction: Joining hands with VLSI to bring you application-specific design solutions.

Teamed up with VLSI Technology, Inc. (VLSI), Arrow has a firm grip on solutions to all your application-specific problems.

VLSI is a recognized leader in the most advanced design and process technologies offering: the widest range of application-specific integrated circuits (ASICs), standard cells, megacells, gate arrays and silicon compilers; memory products that include high-speed RAMs, CMOS EPROMs and a variety of special-purpose RAMs and ROMs; logic products for specific applications, such as floppy disk, serial channel, and DRAM controllers and high-speed CMOS multipliers; and proven, first-time success in fabricating 3-, 2-, and even 1.5-micron designs.

All of these capabilities are aimed directly at meeting the particular needs of your application. In the fastest, most cost-effective way possible.

How can you get your hands on these VLSI products and capabilities? Just call your local Arrow office. We've made a commitment to bring you all VLSI has to offer, and our real-time distribution network lets us do just that. In an instant, we can locate the parts you need, on the full line of VLSI's standard and memory products.

What's more, our nationwide network of Programming Centers can program your VLSI components to exact specifications. And deliver them to you fast, in small engineering quantities or in large volume production.

In fact, our commitment is so strong, we already have two ASIC design centers fully operational and plan to open two more this year. So we can supplement VLSI's existing network.

For more information about how Arrow and VLSI can solve your application-specific design problems, fill out the attached coupon or call your local Arrow office. And find out why we have your future well in hand.

Arrow Electronics, Inc.
25 Hub Drive, Melville, NY 11747
Attn: Mary Hughes, Dept. B7

☐ Please send me information about VLSI products and capabilities.
☐ Please send me information about Arrow Programming Centers.
☐ Have an Arrow salesperson contact me.

Name____________________
Title____________________
Company____________________
Address____________________
City__________ State____ Zip______
Phone____________________

EDN6/26

Arrow. Get in on the Action.

ALABAMA
Huntsville (205) 837-6955

ARIZONA
Phoenix (602) 968-4800

CALIFORNIA
East Bay (415) 487-4600
Los Angeles (818) 701-7500
Orange County (714) 838-5422
Sacramento (916) 925-7456
San Diego (619) 565-4800
San Francisco (408) 745-6600

COLORADO
Denver (303) 696-1111

CONNECTICUT
Wallingford (203) 265-7741

FLORIDA
Clearwater (813) 576-8995
Fort Lauderdale (305) 429-8200
Melbourne (305) 725-1480

GEORGIA
Atlanta (404) 449-8252

ILLINOIS
Chicago (312) 397-3440

INDIANA
Indianapolis (317) 243-9353

IOWA
Cedar Rapids (319) 395-7230

MARYLAND
Baltimore (301) 995-0003

MASSACHUSETTS
Boston (617) 933-8130

MICHIGAN
Detroit (313) 971-8220
Grand Rapids (616) 243-0912

MINNESOTA
Minneapolis (612) 830-1800

MISSOURI
St. Louis (314) 567-6888

NEW HAMPSHIRE
Manchester (603) 668-6968

NEW JERSEY
Fairfield (201) 575-5300
Marlton (609) 596-8000

NEW MEXICO
Albuquerque (505) 243-4566

NEW YORK
Long Island (516) 231-1000
Rochester (716) 427-0300
Syracuse (315) 652-1000

NORTH CAROLINA
Raleigh (919) 876-3132
Winston-Salem (919) 725-8711

OHIO
Cleveland (216) 248-3990
Columbus (614) 885-8362
Dayton (513) 435-5563

OKLAHOMA
Tulsa (918) 665-7700

OREGON
Portland (503) 684-1690

PENNSYLVANIA
Philadelphia (215) 928-1800
Pittsburgh (412) 856-7000

RHODE ISLAND
East Providence (401) 431-0980

TEXAS
Austin (512) 835-4180
Dallas (214) 380-6464
Houston (713) 530-4700

UTAH
Salt Lake City (801) 972-0404

WASHINGTON
Seattle (206) 643-4800

WISCONSIN
Milwaukee (414) 792-0150

PUERTO RICO
San Juan (809) 723-6500

CANADA
Montreal (514) 735-5511,
Ottawa (613) 226-6903
Quebec City (418) 687-4231
Toronto (416) 661-0220

Arrow International TWX: (510) 224-6021

ARROW ELECTRONICS, INC.

CIRCLE NO 87

TABLE 1—CAE SOFTWARE FOR 32-BIT WORKSTATIONS *(Continued)*

		WORKSTATION				FUNCTION							
COMPANY	PROGRAM	APOLLO DOMAIN	DEC VAXSTATION II	HEWLETT-PACKARD 9000 SERIES 320	SUN MICROSYSTEMS SUN-3	SCHEMATIC CAPTURE	LOGIC SIMULATION	CIRCUIT SIMULATION	FAULT SIMULATION	IC LAYOUT	IC-LAYOUT VERIFICATION	PC-BOARD LAYOUT	COMMENTS
LUCASFILM	CADROID				●	●							HIERARCHICAL DESIGN
MANAGEMENT SCIENCES	PREDICTOR		●										MIL-SPEC ANALYSIS
MENTOR	IDEA STATION	●				●	●	●	●	●	●	●	PARALLEL PROCESSING
META-SOFTWARE	HSPICE	●	●		●			●					FAST CONVERGENCE
MIRASHANTA	REDUCE				●								LOGIC REDUCTION
MOSAID	MOSAID 1000		●					●					TRANSISTOR MODELER
OMNICAD	OMNI BOARDS	●	●			●	●					●	ACCELERATED ROUTING
OPTIMA	OPTIMATE	●	●									●	16 SIGNAL LAYERS
PACIFIC NUMERIX	PCB THERMAL	●		●									THERMAL ANALYSIS
P-CAD	CUPL				●		●						PLD SIMULATOR
PHOENIX DATA	LOGCAP		●			●	●		●	●	●		VERIFICATION ON APOLLO
QUANTIC	GREENFIELD		●	●				●					HIGH-FREQUENCY ANALYSIS
RACAL-REDAC	VISULA	●	●			●	●		●			●	HIGH-DENSITY BOARDS
RCA	CADDAS		●			●	●			●	●		ASIC DESIGN
SCIENTIFIC CALCULATIONS	SCICARDS		●			●						●	THERMAL ANALYSIS
SDA	CUSTOMEDGE	●	●	●	●	●	●	●	●	●	●		ASIC TOOLS
SEATTLE SILICON	CONCORDE	●	●							●	●		SILICON COMPILER
SHERPA	DMS		●										FILE MANAGER
SHIVA	POWERSPICE				●			●					ACCELERATED SIMULATOR
SILICON COMPILERS	GENESIL	●	●			●	●			●	●		MODEL GENERATOR
SILICON DESIGN	GDT	●			●	●	●	●		●	●		MIXED-MODE SIMULATOR
SILVACO	UTMOST			●				●					PARAMETER EXTRACTOR
SILVAR-LISCO	SL-2000	●	●		●	●	●			●	●		CUSTOM-IC LAYOUT
SIMUCAD	SILOS	●	●		●		●		●				17 MOS STATES
STAVELEY	WWRAP		●										WIRE-WRAP LAYOUT
SYSCON	217 PREDICT		●										MIL-SPEC ANALYSIS
SYSTEMS CONTROL	CTRL-C				●								MATHEMATICS PACKAGE
TECHNICAL SOFTWARE	SSPACK				●								STATE-SPACE ANALYSIS
TECHNOLOGY MODELING	GEMINI	●	●										TRANSISTOR MODELER
TEKTRONIX	WORKSYSTEM	●	●			●	●	●	●	●	●	●	FILE MANAGER
TERADYNE	LASAR-6	●	●										TESTER INTERFACE
TEXAS INSTRUMENTS	TDU	●					●		●				ASIC DESIGNER
THOMSON	ESOPE	●						●					MICROWAVE ANALYSIS
VALID	SCALD		●			●	●	●	●	●	●	●	HARDWARE MODELER
VECTRON	DNA 2000	●	●			●						●	GRAPHICS ACCELERATOR
VIA	WORKSYSTEM		●		●	●	●	●	●	●	●		BLOCK LAYOUT
VTI	VTITOOLS	●	●	●		●	●	●	●	●	●		ASIC DESIGN
ZYMOS	ZYPSIN		●				●						STANDARD CELLS

Without the right connections, your graphic output devices won't get the picture.

Your raster output devices need the right connections to deliver the results you're looking for. Without a high-performance processor to convert graphic images and text fonts to raster format, they'll rob your mainframe of precious time — and that's not a pretty picture.

At KMW, we've got the solution. We were the first manufacturer of graphic element processors. And for almost a decade, we've made the right connections happen for top Fortune 500 companies.

We offer easy answers to the problems of using a variety of raster hard copy devices. Our processors provide ultrafast, reliable graphic element-to-raster conversion. Interconnection to the host is made via our field-proven communications products or our Auscom channel interfaces. And most popular graphics software allows our processors to communicate with popular graphics and CAD/CAM systems.

With KMW, you'll cut computer overhead normally required for vector conversion or graphics composition, eliminate the expense of trying to develop a solution in-house, and reduce the time for designing new products.

We have processors for controlling laser printers, electrostatic printers/plotters, a large variety of low cost raster hard copy devices, and integration of graphic images and text.

Our processors incorporate advanced multiplane imaging features, including color separation, resolution conversion, and sophisticated font handling features. We can also provide custom products.

Focus on the right connections with KMW. Call today 1-800/531-5167 (in Texas, 512/288-1453) or write KMW Systems Corporation, 8307 Highway 71 West, Austin, Texas 78735.

**KMW
SYSTEMS
CORPORATION**

For the right connections

Auscom is now a division of KMW Systems Corporation.

CIRCLE NO 88

TABLE 2—32-BIT MONOCHROME WORKSTATIONS

COMPANY	APOLLO	DEC	HEWLETT-PACKARD	IBM	SUN
WORKSTATION MODEL	3000	VAXSTATION II/RC	9000 SERIES 320	RT PC 6150-25	3/52M
BASE PRICE	$9900	$14,995	$8,000	$17,940	$13,900
MICROPROCESSOR	68020	MICROVAX II-CPU	68020	RISC	68020
CLOCK FREQUENCY	12 MHz	20 MHz	16 MHz	5.9 MHz	15 MHz
MAIN MEMORY	2M TO 4M BYTES	3M TO 5M BYTES	1M TO 7.5M BYTES	2M TO 4M BYTES	4M BYTES
BUS	PC/AT	NONE	DIO	PC/AT	NONE
HARD-DISK DRIVE	72M BYTES $4500	71M BYTES	55.5M BYTES $6000	70M BYTES	71M BYTES
TAPE DRIVE	60M BYTES $2000	95M BYTES	55.5M BYTES $3200	55M BYTES $1795	60M BYTES
FLOATING-POINT COPROCESSOR	68881	MICROVAX II-FPU	68881	IBM $850	68881 $700
OPERATING SYSTEM	AEGIS AND DOMAIN/IX	MICROVMS OR ULTRIX	HP-UX	AIX $3400	SUN UNIX
DISPLAY SIZE	19 IN.	19 IN.	17 IN. $3500	15 IN. $1150	19 IN.
DISPLAY RESOLUTION	1280 × 1024	1024 × 864	1024 × 768	1024 × 768	1152 × 900
TOTAL PRICE*	$16,400	$14,995	$20,700	$25,135	$14,600

*TOTAL PRICE INCLUDES MINIMUM MEMORY, HARD-DISK AND CARTRIDGE-TAPE DRIVE, FLOATING-POINT COPROCESSOR, DISPLAY, AND OPERATING SYSTEM.

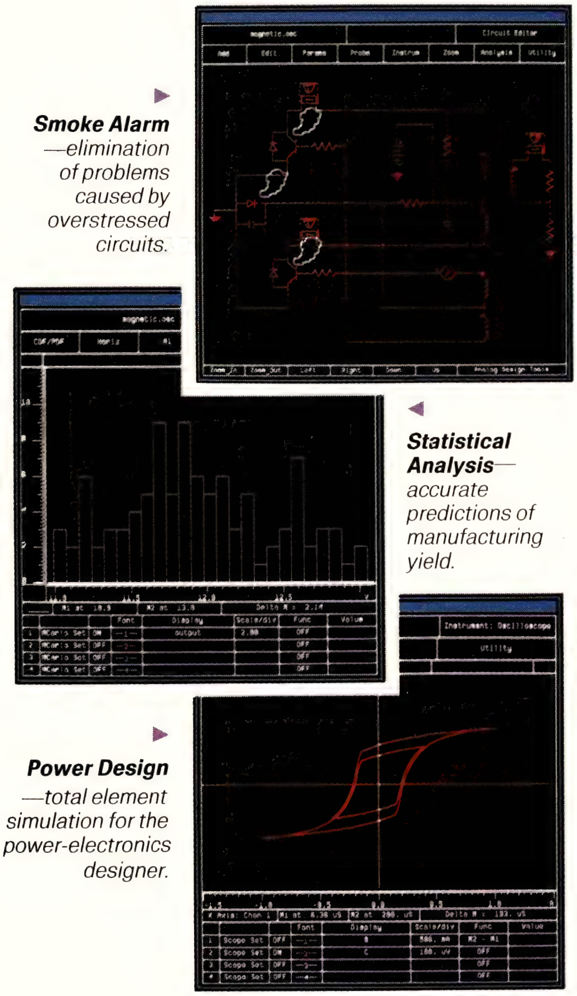
TABLE 3—32-BIT COLOR WORKSTATIONS

COMPANY	APOLLO	DEC	HEWLETT-PACKARD	IBM	SUN
WORKSTATION MODEL	3000	VAXSTATION II/GPX	9000 SERIES 320	RT PC 6150-25	3/160C
BASE PRICE	$14,900	$35,000	$8000	$17,940	$31,900
MICROPROCESSOR	68020	MICROVAX II-CPU	68020	RISC	68020
CLOCK FREQUENCY	12 MHz	20 MHz	16 MHz	5.9 MHz	16.7 MHz
MAIN MEMORY	2M TO 4M BYTES	3M TO 9M BYTES	1M TO 7.5M BYTES	2M TO 4M BYTES	2M TO 16M BYTES
BUS	PC/AT	Q BUS	DIO	PC/AT	VME
HARD-DISK DRIVE	71M BYTES $4500	71M BYTES	55.5M BYTES $6000	70M BYTES	71M BYTES $7900
TAPE DRIVE	60M BYTES $2000	95M BYTES	55.5M BYTES $3200	55M BYTES $1795	60M BYTES
FLOATING-POINT COPROCESSOR	68881	MICROVAX II-FPU	68881	IBM $850	68881
OPERATING SYSTEM	AEGIS AND DOMAIN/IX	MICROVMS OR ULTRIX	HP-UX	AIX $3400	SUN UNIX
DISPLAY SIZE	19 IN.	19 IN.	19 IN. $6050	14 IN. $1550	19 IN.
DISPLAY RESOLUTION	1024 × 800	1024 × 864	1024 × 768	720 × 512	1152 × 900
SIMULTANEOUS COLORS	16	16	16	16	256
TOTAL PRICE*	$21,400	$35,000	$23,250	$25,535	$39,800

*TOTAL PRICE INCLUDES MINIMUM MEMORY, HARD-DISK AND CARTRIDGE-TAPE DRIVE, FLOATING-POINT COPROCESSOR, DISPLAY, AND OPERATING SYSTEM.

Maybe someday, all CAE systems will do this.

The Analog Workbench does NOW.



Smoke Alarm
—elimination of problems caused by overstressed circuits.

Statistical Analysis—
accurate predictions of manufacturing yield.

Power Design
—total element simulation for the power-electronics designer.

The Analog Workbench,™ the CAE system conceived exclusively for analog circuit design—by analog designers—now has three new, interactive, integrated analog design tools that make it possible for you to determine safe operating conditions and improve circuit reliability and manufacturing yield before you build any hardware, and to design analog power electronics—all with the speed and precision of CAE. All three modules are unique to the Analog Workbench, all three were created exclusively for the analog designer, and you already know how to use them.

Determine safe operating conditions. Our *Smoke Alarm*™ module allows you to determine safe operating conditions for your design—effectively eliminating problems caused by overstressed circuits. It identifies marginal conditions based on peak (or average) power dissipation, voltage, current, and junction temperature. Secondary breakdown effects for semiconductor devices and temperature effects of all components are used in the analyses.

Predict manufacturing yield. Our *Statistical Analysis Module* simulates the effects of component parameter tolerances on the performance of the circuit being designed. This makes it possible to predict a circuit's manufacturing yield and directly reduce production costs. With this module you eliminate costly, time-consuming changes at the prototype and production stages.

Design power electronics. Our *Power Design Module* simulates the elements of a power system. It includes an advanced nonlinear magnetics model with hysteresis and core saturation effects, a library of core elements created specifically for the magnetics model, and a library of power devices, including semiconductor and controller IC models for switching-mode power supply design.

Now, more than ever, the Analog Workbench has the tools you need to *create quality circuit designs—the first time*. And they're the tools you already know how to use—Analog Design Tools.™

ANALOG
DESIGN
TOOLS

Contact us today for our new full-color brochure—and ask about our product-demonstration video tape. *Analog Design Tools, Inc.*, 66 Willow Place, Menlo Park, California 94025 (415) 328-0780.

Analog Design Tools, Analog Workbench and Smoke Alarm are trademarks of Analog Design Tools, Inc.

CIRCLE NO 89

OF CO
A PROGRAMMA

You've known it all along.

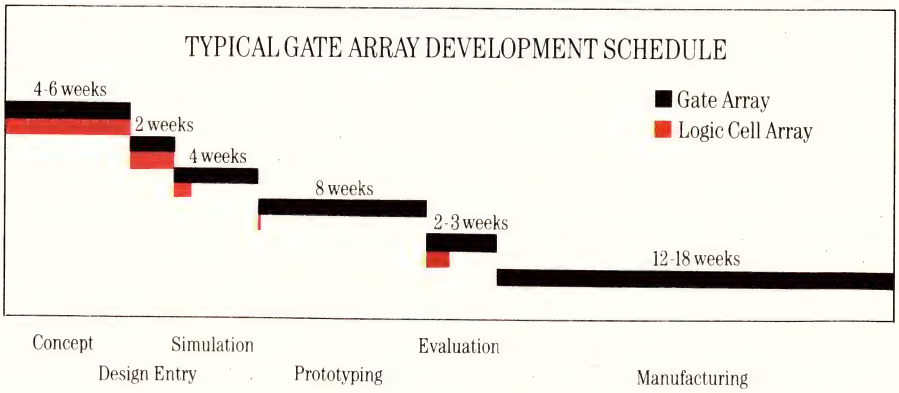
Now, the ideal logic device is finally here: Real gate array density. Real gate array architecture. Real gate array flexibility. And fully user programmable.

It's called the Logic Cell™ Array and it's from Xilinx.

A GATE ARRAY. ONLY BETTER.

The Logic Cell Array offers all the advantages—but none of the disadvantages—of conventional gate arrays. Unlike them, the Logic Cell Array isn't manufactured. Merely programmed. And it can be reprogrammed an unlimited number of times. Even while it's in the system.

That means turnaround time on design revs can be measured in hours, not months. Time-to-market can be reduced accordingly. And non-recurring engineering charges are non-existent.



Since you program it yourself, the Logic Cell Array shortens design verification and prototyping to almost nothing, and completely eliminates manufacturing. That cuts about 5½ months out of the typical schedule. And that's just on the first go-round. If you have to change the Logic Cell Array, all you do is reprogram it. That could take you a whole afternoon.

Logic Cell Arrays are also standard parts. So we can test every one of them 100%, down to the last transistor, before you ever get them.

It also means that, unlike gate arrays, you can get Logic Cell Arrays off-the-shelf, through distribution.

The specs on this little silicon gem?

Part No. XC-2064. CMOS. 40 MHz. And 1200 honest, usable gates. Look for 3000 gates by year-end.

LOGIC THAT WORKS LIKE A MICROPROCESSOR.

The problem with logic devices, gate arrays in particular, is they're hard-wired. So your design is literally cast in silicon.

It might as well be cast in cement.

Imagine, though, how much simpler your life would be if your logic device had the flexibility of

With the Logic Cell Array's real time in-ciruit emulation, you get 100% design verification, in the system. It's the real thing. The best you can do with a gate array is simulation. Which is about as close to the real thing as a decoy is to a real duck. So how can you really be sure your design is going to fly?

Xilinx, Logic Cell, and XACT are trademarks of Xilinx, Inc. IBM is a registered trademark and PC AT and XT are trademarks of International Business Machines Corporation.

JRSE.
3LE GATE ARRAY.

a microprocessor. Well, the Logic Cell Array has that flexibility. Because it works very much like a microprocessor.

At power up, the Logic Cell Array automatically loads its internal CMOS static memory. This memory defines the logic functions and interconnections within the Logic Cell Array to build your logic circuit.

As for the advantages of such an approach, just go ask the microprocessor guys.

As for the advantages of being based on CMOS memory, talk to those who work with memory about how much they like parts that continually drop in price while increasing in density and performance.

Because the Logic Cell Array is going to do that, too.

A FULL ARRAY OF DEVELOPMENT SYSTEM SUPPORT.

You don't have to be an expert in semiconductor manufacturing to use the Logic Cell Array. You just have to know logic design.

And you don't have to be a programming expert to use any part of our integrated development system, either.

There's an interactive, graphics-based, mouse-and-menu-driven configuration editor that you can learn in an afternoon.

Instead of a lot of gate arrays that each do one thing, the Logic Cell Array is one gate array that can do everything. Including cut your inventory risk to zero, let you make field upgrades, and eliminate NRE.

A simulator. An in-circuit emulator that runs real I/O and real software in real time for complete and positive design verification.

Plus documentation at the touch of a button and host of other why-didn't-somebody-think-of-that-before facilities.

Best of all, it runs on an IBM® PC XT,™ AT™ or clone. And you can get started for the modest price of just $3600.

TRY IT. $250.

We've arranged a way for you to find out firsthand what you can do with the Logic Cell Array. It's our Evaluation Kit (otherwise known as EK-01). And it's just $250.

It includes enough software and documentation to evaluate your application on a Logic Cell Array, and see if it performs up to snuff. If you decide the Logic Cell Array is just what you need, we'll credit your $250 towards the purchase of our XACT™ development system.

To order, call Hamilton/Avnet toll-free at 1-800-4-HAMILTON. Or contact your local Xilinx sales office or Xilinx representative.

Immediately, if not sooner.

Now that the ideal logic device is here, isn't this the ideal time to use it?

XILINX
The Programmable
Gate Array Company.

© 1986 XILINX Inc., 2069 Hamilton Ave., San Jose, CA 95125, (408) 559-7778

Automated Design and Engineering for Electronics™ East

SEPTEMBER 30-OCTOBER 2, 1986

WORLD TRADE CENTER

BOSTON, MASSACHUSETTS

Plan to attend ADEE East '86—the only user-oriented conference/exhibition on the east coast that offers these opportunities for optimum selection and implementation of CAE and CAD systems for electronic circuit and system design:

- **Discover the latest advances in CAE and CAD**—see live demonstrations of the technology you need to help you increase engineering productivity, enhance design creativity, and produce uniformly high quality products.
- **Learn how to use CAE and CAD to its maximum advantage for your specific needs**—attend the ADEE East '86 Conference Program and come away with invaluable knowledge of the practical applications of this new generation of technology.
- **Compare and evaluate hundreds of CAE and CAD systems, exhibited by the industry's leading suppliers**—you and a team of your colleagues can "comparison shop" for three days in one location to ensure a selection that delivers maximum performance and return on investment.

Start planning now to take advantage of the many educational and purchasing opportunities available to you at ADEE East '86. For registration information complete and return the coupon below.

CEG®
Cahners Exposition Group, Cahners Plaza
1350 E. Touhy Ave. Des Plaines, IL 60017-5060, Telephone: (312) 299-9311
Telex: 256148 CEGCGO DSP (Domestic), 82882 CEGCHGO (International)

Please send advance registration information in ADEE East '86, including details of the exhibition and Conference Program.

Name ____________________ Title ____________

Company ______________________________

Address ______________________________

City ______________ State ________ Zip ________

Bring a team to share the ADEE opportunity! Photocopy this coupon for your colleagues.

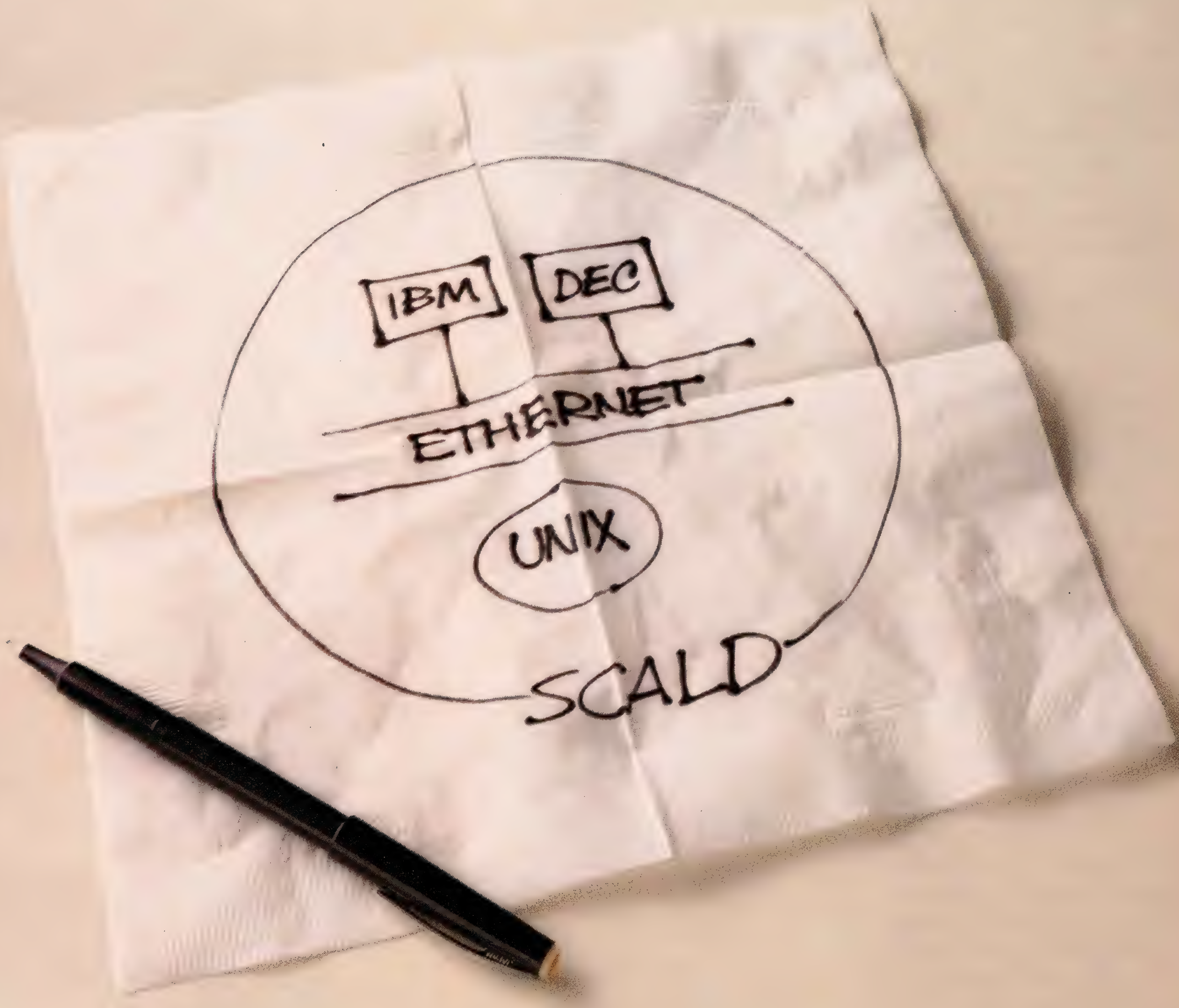
Return to ADEE East '86, **Cahners Exposition Group,** 1350 East Touhy Ave.
P.O. Box 5060, Des Plaines, IL 60017-5060.

D2

Sponsored by: EDN

Endorsed by:
- Electronic Business
- Electronic Packaging and Production
- Design News
- Semiconductor International

© Reed Holdings, Inc. 1986

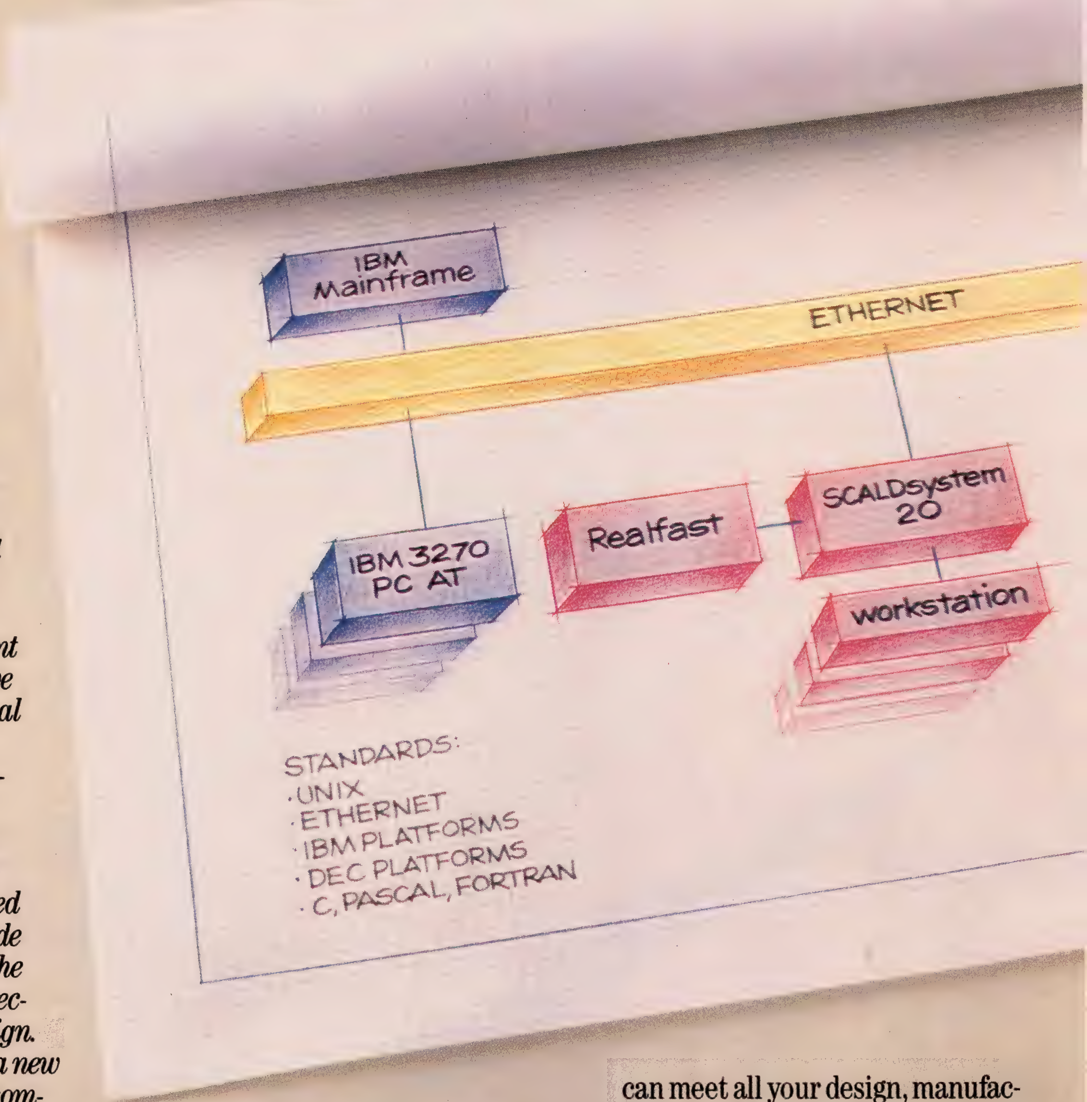


From the beginning...

Valid put CAE and together for solutions

In 1980, a few people met to talk about starting a company with a new design methodology called Structured Computer-Aided Logic Design, or SCALD. Among them were the inventors of SCALD, Tom McWilliams and Curt Widdoes. SCALD's productivity was proven. In fact, it helped Tom and Curt develop the Navy's S-1 super computers in ten-percent of the time it would have taken using conventional design techniques.

SCALD would eventually become a CAE industry standard. But early on, Tom and Curt believed that if combined with other industry-wide standards it would be the ultimate solution for electronic engineering design. Everyone agreed. And a new company was born. A company called Valid.



Our first industry standard was the industry itself.

Valid was the first company to build CAE solutions around SCALD. And from the beginning, our Integrated Engineering System was based on industry standards. Like the UNIX™ operating system. Ethernet™ local area networking. C and Pascal languages. As well as IBM® and DEC™ mainframe computers and workstations.

Our foundation in industry standards protects your computer investment. It gives you the opportunity to integrate Valid's CAE solutions into your current engineering environment, and to use new workstations from IBM and DEC as they come along.

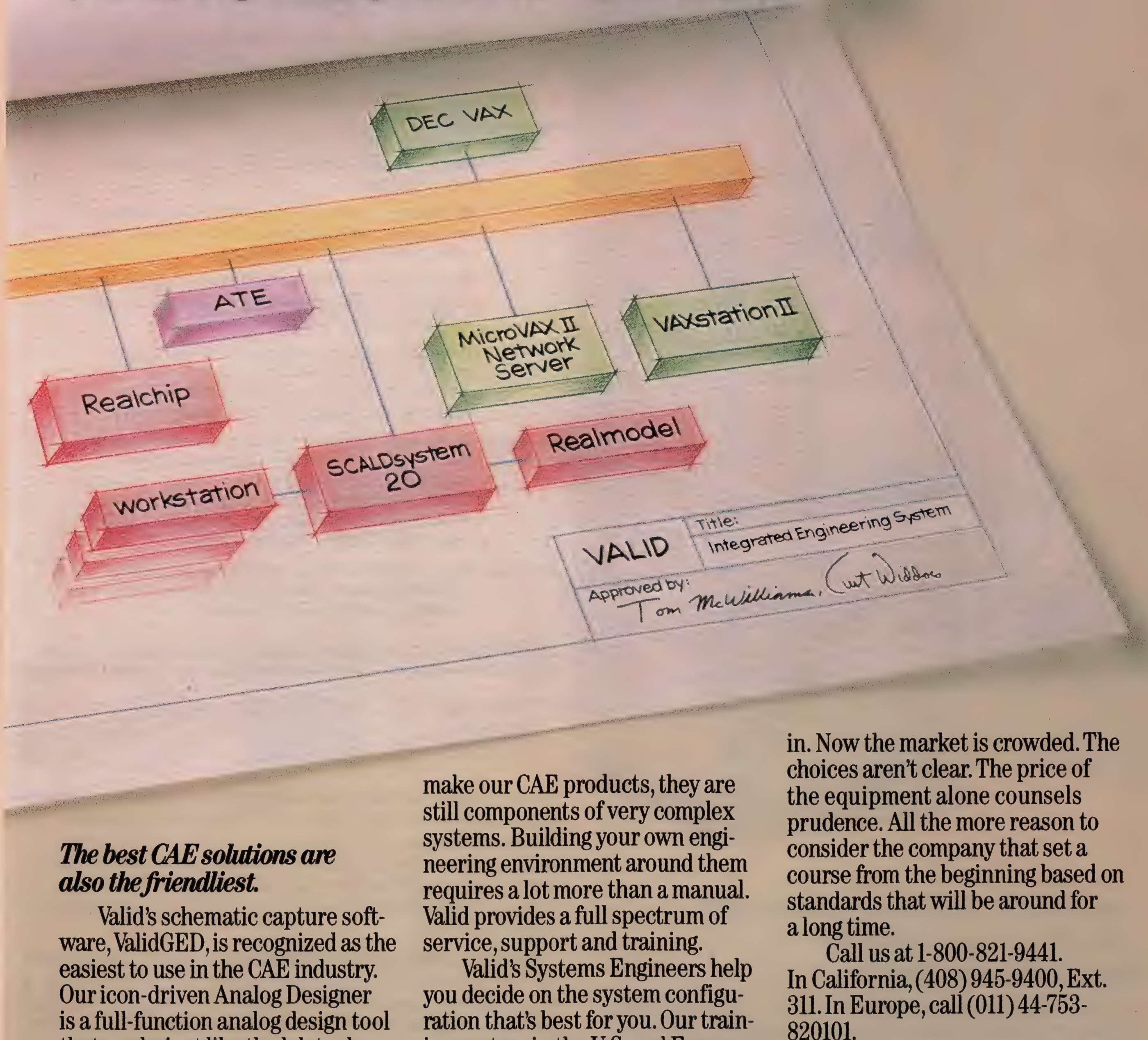
Valid's Integrated Engineering System also provides an open architecture, giving you a growth path to the future. It's an architecture that lets you interconnect equipment from other vendors. For, even with our wide range of CAE and CAD solutions, from design entry to physical layout, no one CAE vendor can meet all your design, manufacturing and test needs.

We believe in co-existence.

Valid's CAE solutions give you the freedom to use hardware and software from other CAE vendors. We've even ported some of them onto Valid's workstations for you. Like the Lasar-6™ simulator from Teradyne. And the Concorde™ Silicon Compiler from Seattle Silicon Technology.

Co-existence allows you to build an engineering environment your way. This flexibility ensures systems evolution, instead of obsolescence.

industry standards that never end.



The best CAE solutions are also the friendliest.

Valid's schematic capture software, ValidGED, is recognized as the easiest to use in the CAE industry. Our icon-driven Analog Designer is a full-function analog design tool that works just like the lab tools it replaces. Virtually any engineer can learn it in five minutes.

Moreover, industry standards make our CAE tools functionally similar across our entire product line. So, when you learn how to use one of our tools on one of our systems, you know how to use it on all of our systems.

First in service, too.

No matter how easy-to-use we make our CAE products, they are still components of very complex systems. Building your own engineering environment around them requires a lot more than a manual. Valid provides a full spectrum of service, support and training.

Valid's Systems Engineers help you decide on the system configuration that's best for you. Our training centers in the U.S. and Europe help train your engineers and systems managers in every phase of CAE systems use. And our Field Engineers are just a phone call away whenever your systems need service. What's more, Valid's toll-free Factory Hot Line can help with immediate problems.

A word of caution.

After SCALD launched the CAE industry, many companies jumped in. Now the market is crowded. The choices aren't clear. The price of the equipment alone counsels prudence. All the more reason to consider the company that set a course from the beginning based on standards that will be around for a long time.

Call us at 1-800-821-9441. In California, (408) 945-9400, Ext. 311. In Europe, call (011) 44-753-820101.

Trademarks: Realchip, Realfast, Realmodel—Valid Logic Systems Incorporated; IBM PC AT—International Business Machines Corporation; DEC, VAX, VAXstation, MicroVAX—Digital Equipment Corporation; Ethernet—Xerox Corporation; UNIX—AT&T Bell Laboratories.
Registered Trademarks: SCALDsystem—Valid Logic Systems Incorporated; IBM—International Business Machines Corporation.

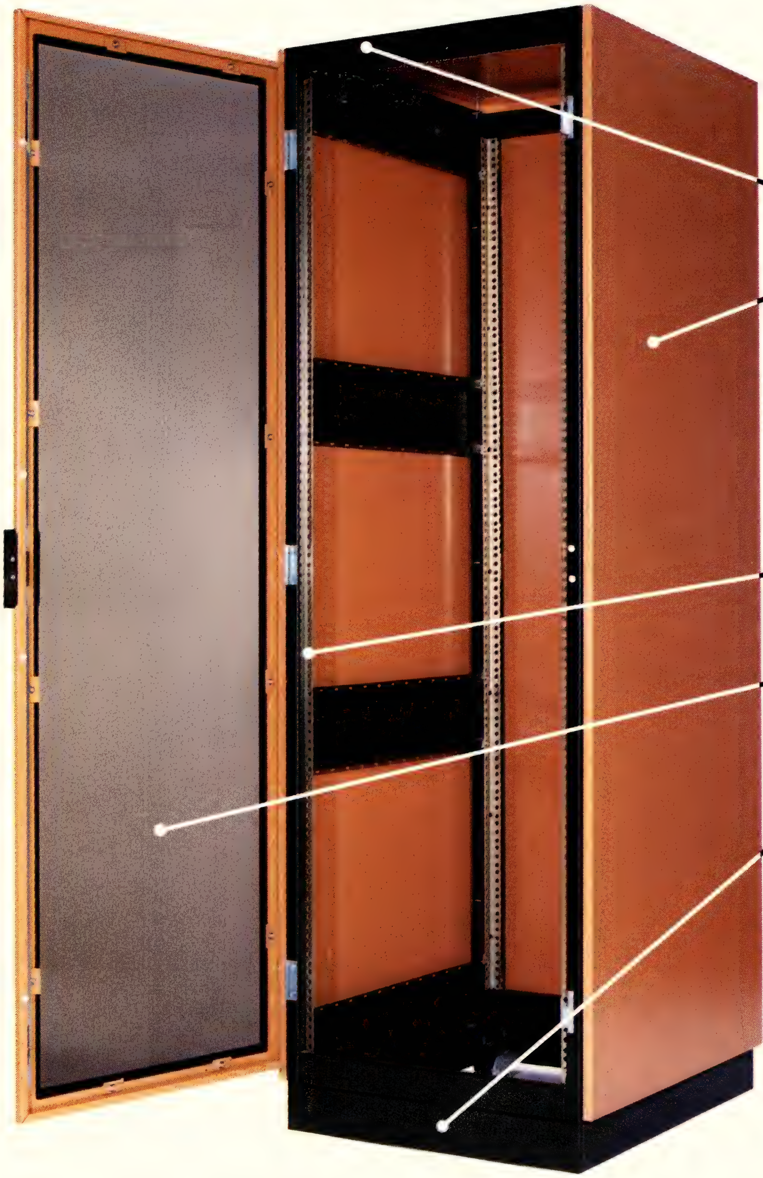
VALID

Industry standard solutions
. . . from the beginning.

CIRCLE NO 91

What to look for when selecting a standard electronic enclosure.

Challenger Commercial Duty Modular Electronic Cabinets



All welded construction—14 gauge transverse members are welded to side frame weldments minimizing twist, sway or deflection. 9 heights, 2 widths and 4 depths.

Universal side panels—Can be securely fastened from the inside of cabinet to prevent tampering, or easily removed externally when ease of access is most important.

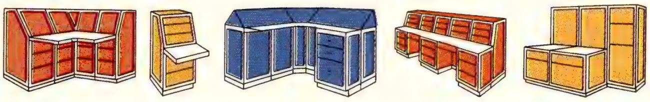
- Mar-proof panel mounting screws can be removed and replaced without marring painted finish around screw holes. An Equipto exclusive.
- All drawers, "Pull-Out" shelves and sliding chassis shelves provided with ball-bearing extension slides for smoothness and long life.

Recessible panel mounting angles—punched or tapped universal E.I.A. hole spacing (in 1¾″ increments). Four supplied with each rack. Zinc plated per Fed. Spec. QQ-Z-325 Type II, Class 3.

Interchangeable doors—doors are easily removed. Face mounting to frame allows recess mounting of equipment. Positive door latching ensures UL and OSHA acceptance. Tints and special effect viewing areas available upon application to factory. Gasketing available to make doors dust tight.

Base can have optional casters, levelers, anti-tip legs, and duplex outlets; or can be removed for installation of heavy duty caster truck.

Available in a variety of modular configurations.



The Challenger System of Modular Electronic Cabinets is perhaps the most versatile line of standard cabinets offered today. Its economy and size selection offers you functional design options to meet all your equipment applications at a competitive price. It also meets our rigid Equipto Electronics quality standards.

Select from a variety of vertical rack and sloped console frame configurations and various panel heights, widths and depths. A multitude of accessories—fans, blowers, turrets, etc., are also available. Eight standard colors—no-charge for special colors.

For details and free catalogs, call or write Equipto Electronics Corporation, 351 Woodlawn Avenue, Aurora, IL 60506-9988. Phone: (312) 897-4691.

Committed To Quality Since 1960

Additional modular enclosure and cabinet system literature available at no charge.

We also offer Heavy-Duty Cabinets, EMI/RFI Cabinets, Solid System Cabinets, Quiptron® Computer Furniture, Instrument Cabinets, Modular Electronic Desk System lines, and for those who can't wait, Express 5 Day Service.

EQUIPTO® Electronics Corporation

We deliver the best—faster

© Equipto Electronics Corporation 1986

CIRCLE NO 92

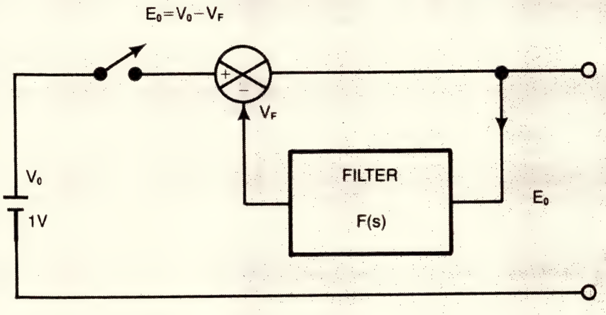
Basic program eases analysis of phase-locked loops

Analyzing second- and third-order phase-locked loops yourself can be a tedious and time-consuming task. Using a Basic program, you can employ a small computer to perform all the necessary tasks much faster.

Ron Rippy, *Durham, NC*

Relying on a Basic program and a computer, you can model a third-order tracking filter (or phase-locked loop) with a linear phase detector and plot the error response E_0 to a phase step of 1 rad **(Ref 1).** A similar approach allows you to analyze PLLs (second- and third-order) with sine-wave phase detectors and compare the two types of loops. You can study the two loops' error response to frequency and acceleration steps as well as to high-level random noise and sine-wave inputs, all of which can drive a loop into the nonlinear phase region of the phase detector.

Fig 1 shows a block diagram of a phase-locked loop along with the Basic program that allows you to calculate and plot E_0 for a third-order loop. (For a detailed description of phase-locked loops, see **box,** "Phase-locked loops provide coherent tracking.") The second-order loop's phase response is expressed by the second-order equation in **Fig 1.** This loop is a high-gain type **(Ref 2),** whereas the third-order loop is a Wiener loop optimized for minimum phase error when the input is a frequency ramp.



THIRD-ORDER EQUATION:

$$E_0 = -2\omega\frac{1}{s}E_0 - 2\omega^2\frac{1}{s^2}E_0 - \omega^3\frac{1}{s^3}E_0 + V_0$$

SECOND-ORDER EQUATION:

$$E_0 = -2d\omega\frac{1}{s}E_0 - \omega^2\frac{1}{s^2}E_0 + V_0$$

WHERE
d=DAMPING FACTOR=0.707
ω=NATURAL FREQUENCY=1 RAD/SEC
s=LAPLACE OPERATOR

```
3000 E0,E1,E2,E3=0 @ V0,W=1
3010 SCALE 0,8,-.5,1.5
3020 XAXIS 0,1 @ YAXIS 0,.1
3030 MOVE 0,0 @ T=.05
3040 FOR X=0 TO 8 STEP T
3050 E1=T*E0+E1
3060 E2=T*E1+E2
3070 E3=T*E2+E3
3080 E0=-(2*W*E1)-2*W*W*E2-W*W*W*E3+V0
3090 DRAW X,E0
3100 NEXT X
3110 END
```

Fig 1—Depending on whether your PLL is a second- or third-order loop, *phase response is expressed by either a second- or third-order equation. The Basic listing solves the third-order equation.*

The second-order loop doesn't lock when subjected to a 1-rad/sec² acceleration step, its acceleration pull-out step size.

To change from a linear to a sine-wave phase detector, you simply replace E_0 on line 3050 of the program with sin(E_0). Thus, E_0 equals sin(V_0-V_F) rather than simply V_0-V_F, as shown in **Fig 1.** To change V_0 to an n rad/sec frequency step, or an n rad/sec² acceleration step, you enter n*X or n*X*X/2, respectively, for V_0 on line 3080. To change V_0 to an n radian peak sine wave, you enter n*SIN(W*X) in place of V_0.

Fig 2 illustrates the second- and third-order loops' error response to unity-phase, frequency, and acceleration steps. *(Ed Note: For all figures, the second- and third-order plots are shown as dashed and solid lines, respectively.)* Note that when the second-order loop is subjected to a 1-rad/sec² acceleration step (the acceleration pull-out (APO) step size), it doesn't lock. It will lock for a 0.9-rad/sec² acceleration step, but it will have approximately a 1.1-rad steady-state phase error. On

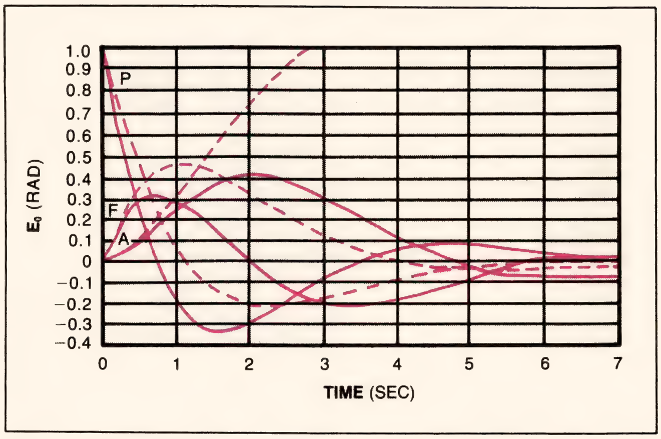


***Fig 2—Plotting the PLLs' phase error** resulting from unity-phase (P), frequency (F), and acceleration (A) steps shows that the third-order loop can track a unity acceleration step, but the second-order loop cannot.*

Phase-locked loops provide coherent tracking

A phase-locked loop, or PLL, is a circuit that locks the frequency of one oscillator to that of a second oscillator. In **Fig Aa,** the master oscillator's phase is V_0, and the slave voltage-controlled oscillator (VCO), which locks to and follows the frequency of V_0, has a phase of V_F.

The phase detector subtracts V_F from V_0 to produce a voltage E_0 that's proportional to the phase difference (error) between the two oscillators. After amplification and filtering, E_0 feeds back to the VCO, forcing a frequency change that reduces (or totally eliminates, in some loops) the phase error. To realize a lock condition, the steady-state frequency (but not the phase) error must be 0.

The loop filter prevents high-frequency noise and modulation on V_0 from reaching the VCO. This filtering ensures that the VCO will follow only slow changes in the frequency of V_0.

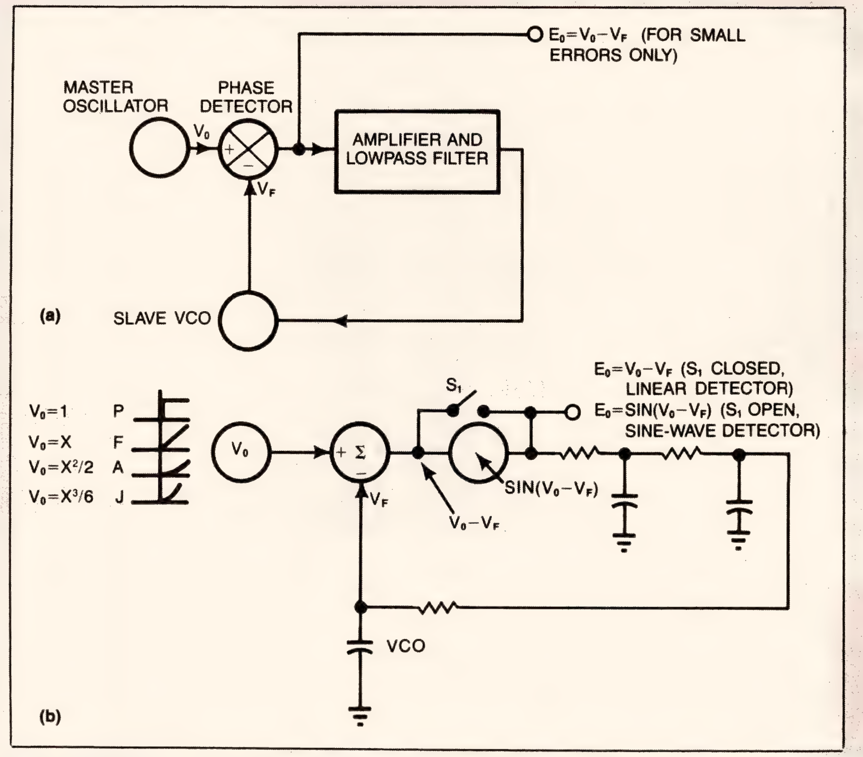

$E_0=V_0-V_F$ (FOR SMALL ERRORS ONLY)
MASTER OSCILLATOR
PHASE DETECTOR
V_0
+
−
V_F
AMPLIFIER AND LOWPASS FILTER
(a)
SLAVE VCO
$E_0=V_0-V_F$ (S_1 CLOSED, LINEAR DETECTOR)
S_1
$E_0=SIN(V_0-V_F)$ (S_1 OPEN, SINE-WAVE DETECTOR)
$V_0=1$ P
$V_0=X$ F
$V_0=X^2/2$ A
$V_0=X^3/6$ J
V_0
+ Σ
−
V_F
$SIN(V_0-V_F)$
V_0-V_F
VCO
(b)

***Fig A—In a basic PLL (a),** any disturbance in V_0 (the phase ramp from the master oscillator) produces an error E_0, which forces V_F (the phase ramp from the slave oscillator) to match and cancel V_0. In the conceptual diagram **(b)**, the loop behaves as if S_1 is closed for small (less than 1 rad) phase disturbances in V_0 and open for larger disturbances.*

the other hand, the third-order loop, with its additional integrator, is able to reduce the steady-state error to 0.

You'll find that as you try increasingly larger phase steps, both loops unlock at 3.2 rad, but remain in lock at 3.1 rad (**Fig 3**). Lock loss occurs at 3.2 rad (just over 3.14 rad, actually) because the sine-wave phase detector sends the wrong polarity voltage to the loop filter when the error exceeds π rad. The wrong polarity voltage causes the phase error to increase rather than decrease.

In **Fig 4,** ωPO (the frequency pull-out that causes loss of lock) occurs at 3.1 rad/sec in the second-order loop and 4.7 rad/sec in the third-order loop. The values correspond to a normalized loop frequency of 1 rad/sec. **Fig 5** shows that APO equals 1 rad/sec^2 for the second-order loop, and 3 rad/sec^2 for the third-order loop. JPO (the phase-jerk pull-out, or linearly increasing accelera-

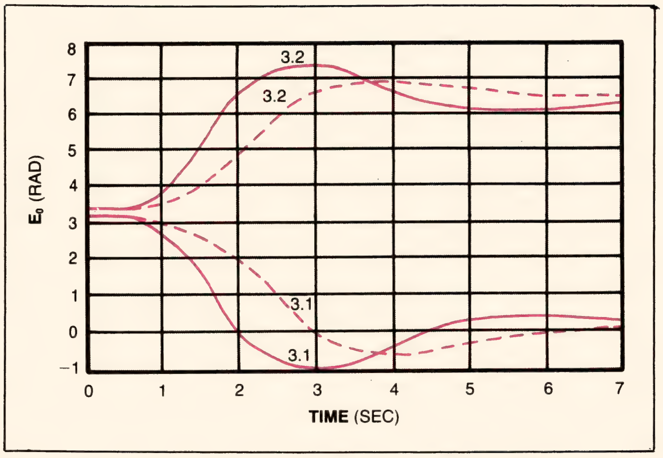


Fig 3—Neither loop remains locked *for phase steps above 3.1 rad. The sine-wave detector forces both loops to relock at 2π rad—behavior referred to as cycle slipping.*

The phase detector provides an output proportional to sin(V_0-V_F). For small phase errors, sin(V_0-V_F)≈V_0-V_F, and the output is linearly proportional to the phase error. For large errors like those that occur when the loop is about to lose lock, however, the output traces a sine wave.

The error voltage peaks at π/2; it then decreases even though the error continues to increase. This behavior is a result of the slope reversal of the sine wave above π/2 and is a source of instability in the loop. In fact, the loop may make the error larger rather than smaller.

The loop will not necessarily lose lock just because the error exceeds π/2. The shape and duration of the error waveform also come into play. For example, a phase step won't cause loss of lock until it exceeds π rad. Fortunately, once the error progresses a full 2π rad, the slope of the sine wave is again correct, and the loop may relock. The loop tendency to unlock and then relock in 2π rad is called cycle slipping.

Fig Ab separates the phase detector into linear and nonlinear components and shows the loop consisting of three integrators. The first two integrators following the detector constitute the filter, and the third integrator is the VCO. The VCO is a perfect integrator because a phase step in the oscillator causes a perpetual phase ramp (frequency step) in the output.

Assuming the loop is locked initially, both V_0 and V_F are identical steady-state phase ramps that cancel in the phase detector and leave no phase error. This quiescent condition poses no problem, of course. What is important is what happens to E_0 when a disturbance takes place in V_0. If two loops have identical bandwidth, the one that can withstand the greater disturbance and remain in lock is considered superior.

Fig A lists four disturbances—phase step (P), frequency step (F), acceleration step (A), and jerk step (J)—that are popular for testing loops. Each successive disturbance is an integral of the previous one, and you substitute each one for V_0 on line 3080 of the Basic program.

In general, a loop with only one integrator (the VCO) will track phase disturbances having first-order or lower curvature (such as P and F). A loop with two integrators will track disturbances having second-order or lower curvature (eg, P, F, and A). This tracking performance is only possible if the disturbance is slow enough to pass through the loop filter and has a duration that's short enough to prevent the phase excursions from saturating amplifiers or other components in the loop.

If an exact trajectory is important as a loop begins to lose lock, you should keep the sampling step size at 0.01 sec max.

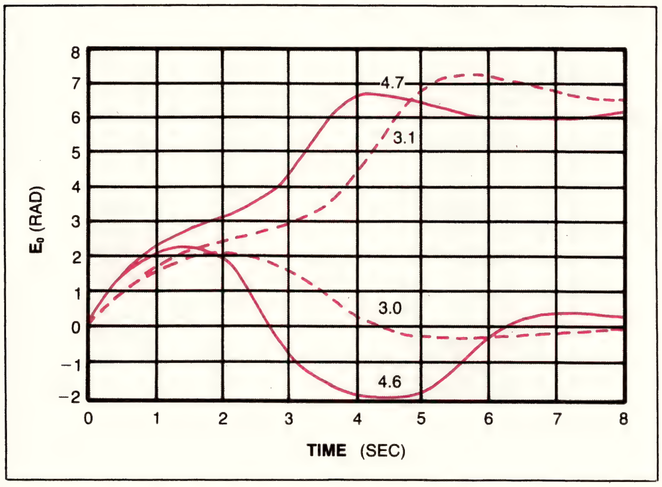


Fig 4—Until cycle slipping begins, *the third-order loop can withstand a larger frequency step than the second-order loop.*

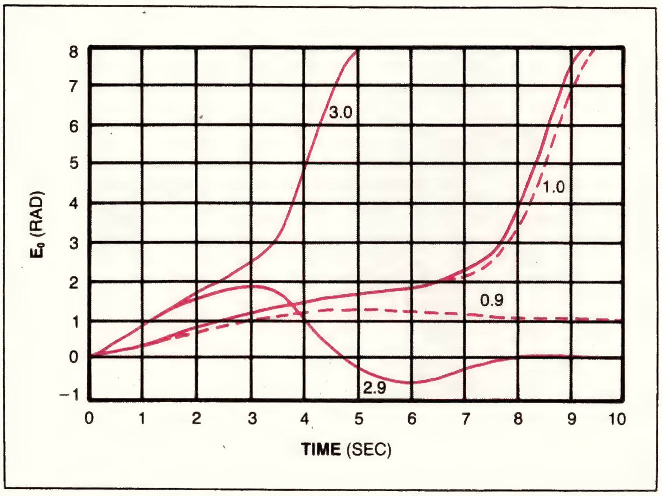


Fig 5—The second-order loop can track an acceleration step *of 0.9 rad/sec^2, but has a 1.1-rad phase error. In contrast, the third-order loop can track a 2.9 rad/sec^2 step with a phase error of 0 rad.*

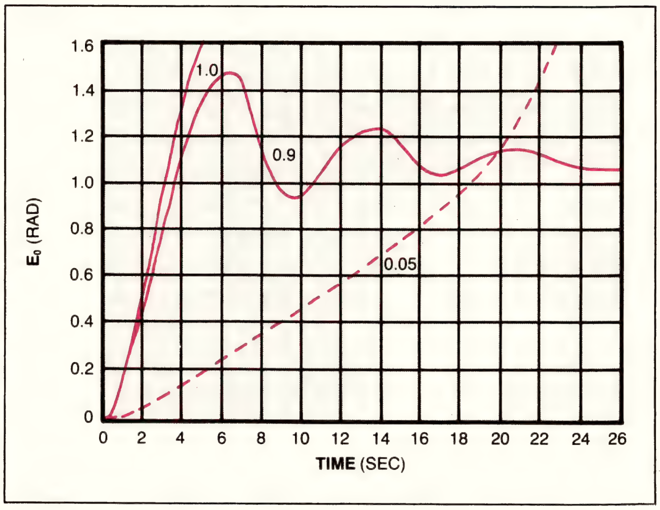


Fig 6—The second-order loop is incapable of tracking *any finite value of jerk. The third-order loop will track a 0.9-rad/sec^3 jerk step, but has a phase error of 1.1 rad.*

tion, that causes loss of lock) measures 1 rad/sec^3 for the third-order loop, and less than 0.05 rad/sec^3 for the second-order loop **(Fig 6).** Evidently, the second-order loop won't remain locked for any finite value of jerk input.

As far as accuracy is concerned, the sampling interval for the numerical integration process (T on line 3030 of the program) is 0.05 sec. If you reduce this interval to 0.01 sec, you'll wind up with the solid curve beside the 1 rad/sec^2 dashed curve in **Fig 5.** Reducing the interval even further (to 0.005 sec, for example) fails to change the curve—there's no noticeable improvement in accuracy.

At a 0.05-sec sampling rate, the error is low where the curves have a small or moderate slope, but it increases (to 0.5 rad or more) in regions where the curves have a steep slope. If it's important to have an exact trajectory as a loop begins to lose lock, then you should use a sampling step size no larger than 0.01 sec.

The set of curves in **Fig 7** reflects the third-order loop's performance for a series of acceleration steps in the 2.9- to 3.04-rad/sec^2 range—just above and below the value that'll lead to lock loss. As the curves illustrate, the loop responds first by locking properly but then begins to slip cycles; it loses lock and then relocks in 6.28-rad increments.

To this point, the results seem to indicate that the third-order loop outperforms the second-order loop. At the very least, the third-order loop accommodates larger frequency and acceleration steps before it loses lock.

Nevertheless, it isn't apparent how the two loops compare when noise is present. Fortunately, you can set up a comparison easily. You just make V_0 a pseudorandom waveform that varies from −3 to +3 rad p-p, an input that makes E_0 very noisy. You then make a plot of V_F, thereby taking advantage of the loop filter's quieting effect. The loop noise bandwidth equals 0.530ω for the second-order loop and $\frac{5}{6}\omega$ for the third-order loop. To equalize the noise level in both loops, ω should equal 1 for the second-order loop and 0.636 for the third-order loop.

The test for both loops uses the same five seed values for the random-noise generator. **Fig 8** shows that the third-order loop loses lock five out of five times, where-

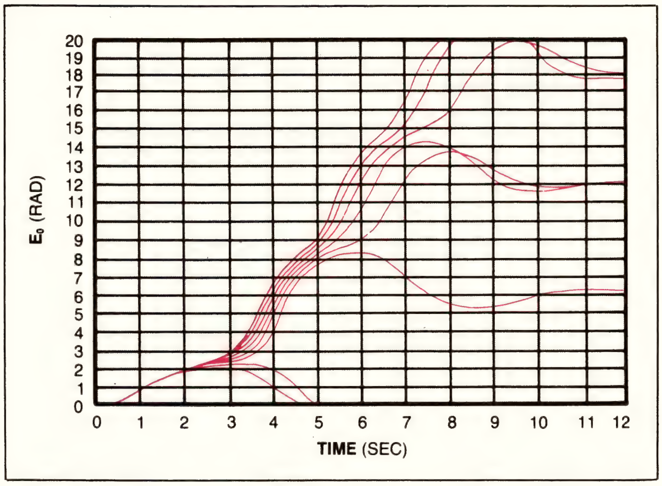


*Fig 7—**Multiple cycle slips occur in the third-order loop** for acceleration steps above 3 rad/sec². The slope of each phase curve is equal to the frequency difference between the master and slave oscillators.*

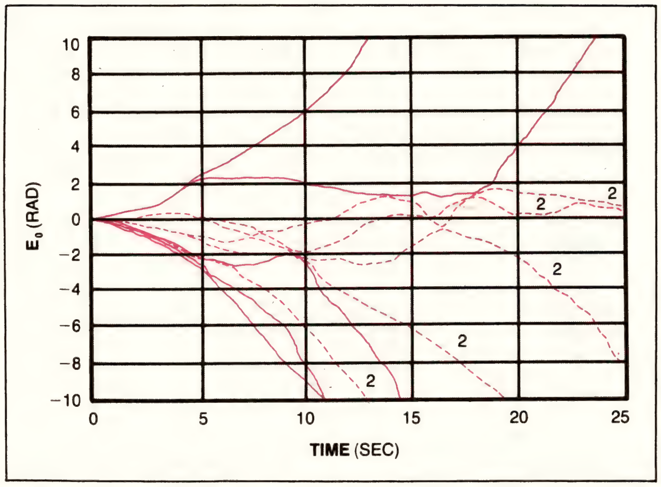


*Fig 8—**At high noise levels,** the third-order loop tends to lose lock before the second-order loop.*

as the second-order loop loses lock just three out of five times. To make the performance of both loops virtually identical, you must reduce ω in the third-order loop to 0.509. This reduction yields a noise bandwidth of $\frac{5}{6}\cdot 0.509=0.424$ rad/sec. The third-order loop shows about a 1-dB degradation in noise performance for these conditions.

Comparing stability of both loops

It's important to compare the stability of both loops. The third-order loop has the potential for becoming unstable: It has one more integrator, and hence more loop phase shift than the second-order loop. If no software is available to make a Bode plot, you can use a large sine wave (at the loop's natural frequency) for V_0 as an experiment. **Fig 9** shows error-voltage test results when V_0 equals 1.5·sin(1·X). As the curves illustrate, E_0 continuously increases in the third-order loop until it loses lock. It takes more than 2 rad to cause a lock loss in the second-order loop. This data indicates that the third-order loop is probably more unstable than the second-order loop.

Table 1 provides a summary of the results of the analyses. The third-order loop withstands larger frequency, acceleration, and jerk steps before losing lock. On the negative side, however, large sustained signals —such as sine waves and noise—cause the third-order loop to lose lock earlier than the second-order loop. The third-order loop's increased phase shift is probably a contributing factor.

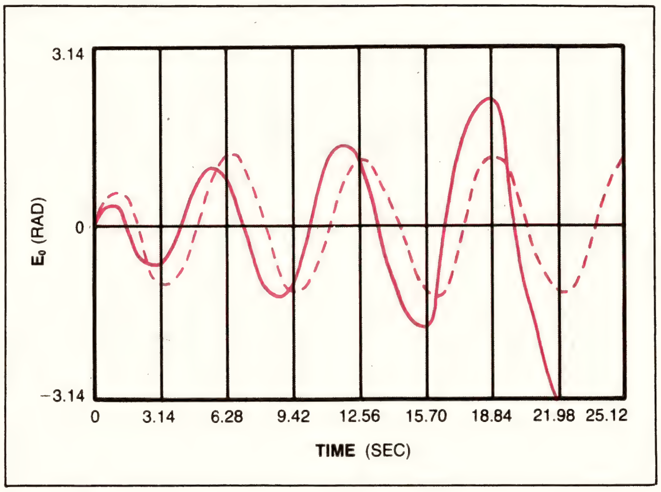


*Fig 9—**The error voltage in the third-order loop** increases until lock is lost when V_0 is a 1.5-rad sine wave. Although the second-order loop looks stable, it loses lock when V_0 is increased to 2.1 rad.*

However, you can't overlook the sine-wave detector as a problem source because no indication of instability exists when you model either loop with a linear phase detector. Unfortunately, once the phase-shift error exceeds π/2 rad, sin(E_0) begins to decrease as E_0 continues to increase. A smaller sin(E_0) will reduce the value of V_F. Since $E_0=V_0-V_F$, E_0 will continue to increase and further decrease the value of sin(E_0). Evidently, the sine-wave detector seems to cause positive feedback.

To illustrate this effect, **Fig 10a** plots various parameters in the second-order loop when V_0=2.1·sin(1.0·X). The arrow indicates approximately where the sequence of events noted above begins to take place. **Fig 10b** shows the same measurements for a second-order loop

Results show that the third-order loop can withstand greater frequency and acceleration steps before losing lock.

TABLE 1—SUMMARY OF SECOND- VS THIRD-ORDER LOOPS WITH SINE-WAVE PHASE DETECTORS

TEST	SECOND ORDER	THIRD ORDER
PPO (RAD)	3.14	3.14
ωPO (RAD/SEC)	3.1	4.7
APO (RAD/SEC^2)	1.0	3.0
JPO (RAD/SEC^2)	>0	1.0
NOISE (3.0 RAD)	THIRD-ORDER LOOP LOSES LOCK BEFORE SECOND-ORDER LOOP. ABOUT 1-dB DIFFERENCE IN PERFORMANCE.	
SINE WAVE (1.5 RAD)	THIRD-ORDER LOOP LOSES LOCK. SECOND-ORDER LOOP LOSES LOCK AT 2.1 RAD.	

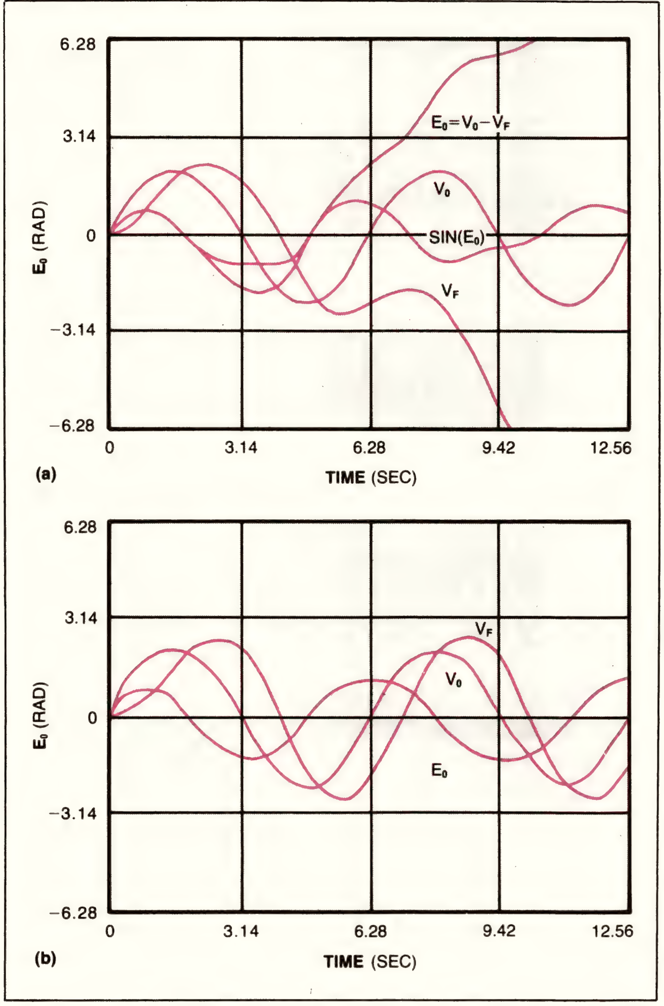


***Fig 10—The feedback from the sine-wave detector** is positive once E_0 exceeds $\pi/2$ rad. As a result, E_0 increases rather than decreases **(a)**. Substituting a linear detector **(b)** for the sine-wave detector results in no evidence of instability.*

that employs a linear detector.

For perfect error correction, V_F should be a mirror image of V_0. Unfortunately, phase and amplitude errors preclude this perfection. It appears that the amplitude error contribution from the sine-wave detector adds to the loop filter's phase error to cause the instabilities observed in these analyses. **EDN**

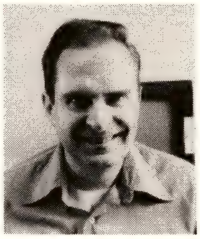
References

1. Rippy, Ron, "Basic programs solve differential equations quickly," *EDN*, February 6, 1986, pg 135.

2. Gardner, F M, *Phaselock Techniques*, 2nd ed, John Wiley & Sons, New York, NY, 1979.

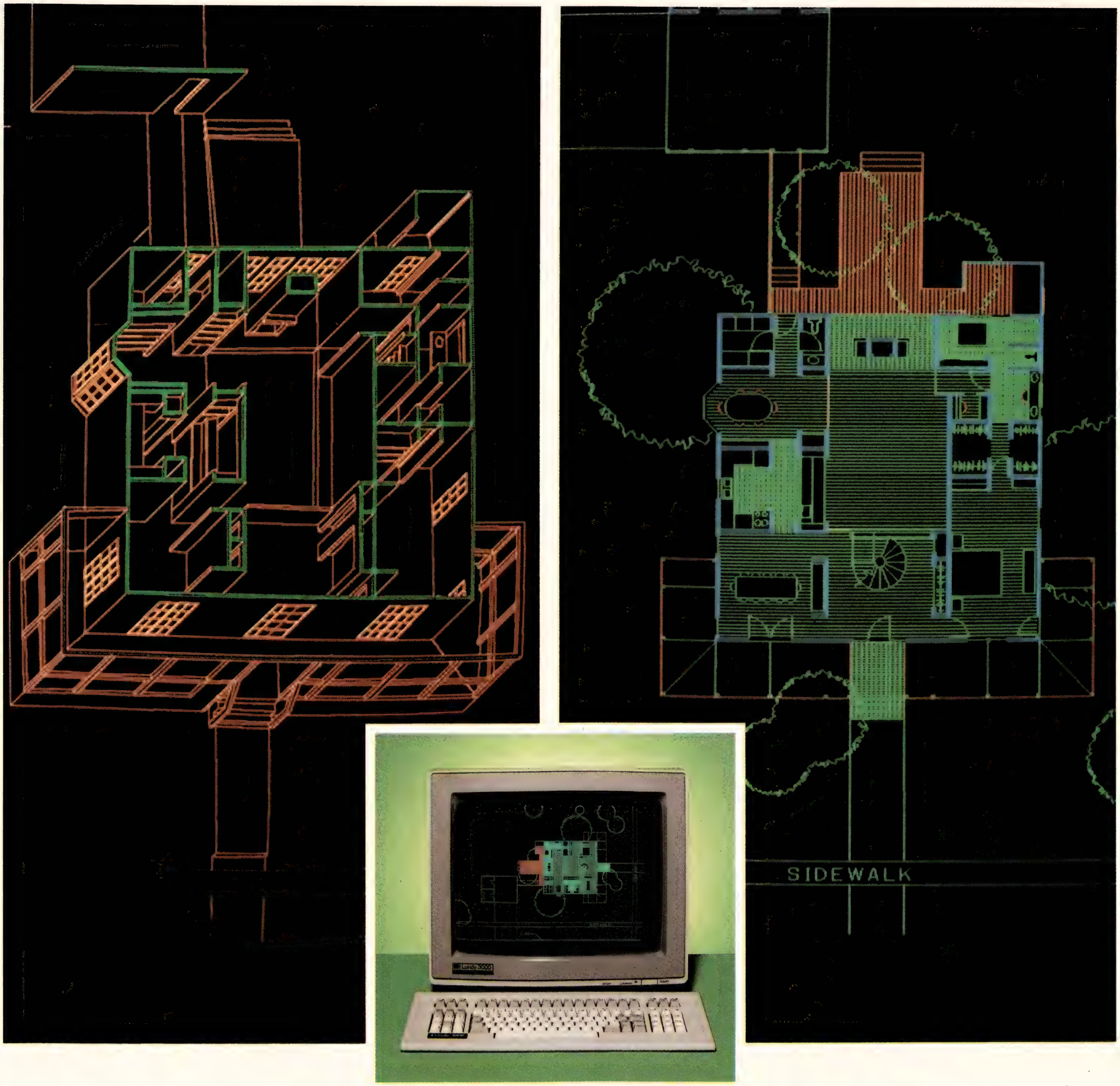
3. Klapper, J, and J T Frankle, *Phase-Locked and Frequency-Feedback Systems*, Academic Press, New York, NY, 1972.

Author's biography



Ron Rippy is an electronics engineer with the Laboratory of Molecular Biophysics at the National Institute of Environmental Health Sciences in Research Triangle Park, NC. Ron designs and maintains nuclear magnetic resonance (NMR) spectrometers and has 22 years of experience in designing RF circuits and in programming computers. He enjoys programming a VAX computer at work and includes reading among his leisure activities.

Article Interest Quotient (Circle One)
High 473 Medium 474 Low 475



Look at What Lundy & Design Graphix™ Are Doing to PC-Based CADD.

Generate a design on the Lundy 3000 workstation and then compare it to a PC-based system. The differences may well amaze you. Lundy 3000 displays your work with a resolution that's simply unattainable with PC-based systems.

Less Strain on Engineers

The sharpness and clarity of the Lundy 3000 permit very detailed, high quality design with less strain on your engineers. This results in overall productivity increases for you and your design staff. Lundy 3000 is ideal for those who can benefit from a graphics system but are reluctant to invest the large sums of money required for advanced systems.

Makes PC's Look Like Toys

When packaged with ESC's Design Graphix™ software, Lundy 3000 becomes an advanced, low cost CADD system with a level of responsiveness that can make PC-based systems look like toys. The flexible, high performance capabilities of Lundy 3000 make it very hard to grow out of. And that's a serious consideration when purchasing a graphics system.

So if you're looking for a graphics system that's low in cost yet high on performance, look to the Lundy 3000 and see how inexpensive quality graphics design can be.
Contact: Graphics Marketing
Lundy Electronics & Systems, Inc.
One Robert Lane, Glen Head,
N.Y. 11545. (516) 671-9000.

LUNDY® LUNDY

DESIGN GRAPHIX™ is a trademark of Engineering Systems Corporation, Baton Rouge, Louisiana.

Two new ways to a better world.

C&C
Computers and Communications

Introducing the economical V60 and the powerful V70. Two ways to succeed in the 32-bit realm.

Claim your share of the 32-bit future by picking the CMOS microprocessor that suits your system needs. Want economy? NEC's new V60 (16-bit external data bus) gives you an easy, affordable path into 32-bit products. Need performance? The V70 is a full 32-bit engine designed to power leading-edge systems.

SPEED.

V60/V70 supermicros offer a clock speed of 16MHz. They execute 3.5 MIPS and 6 MIPS respectively. And feature a six-stage pipelined CPU for concurrent execution of up to 4 instructions. There's no need to access slow off-chip memory. Because V60/V70 give you 32 on-board 32-bit general-purpose registers.

MULTI-TASKING, MULTI-USER.

The V60 and V70 feature an on-chip memory management unit with 4 gigabytes of demand-paged virtual memory space. And 4 levels of memory protection.

POWERFUL INSTRUCTION SET.

The V60/V70 instruction set is ideal for high-level languages and OS support (UNIX™ V and proprietary realtime OS). You get 21 addressing modes. 273 instructions. An emulation mode for 16-bit V20/V30 software. Greater programming flexibility. And new ease in generating optimized code.

COST EFFICIENT.

With its 16-bit data bus, V60 is the most economical design-in for 32-bit applications including; office automation, CAD/CAM workstations, time-sharing systems and realtime control.

NEC keeps costs down through innovative production techniques. V60/V70 are the densest CMOS microprocessors. And the first to integrate an MMU and basic floating-point processing functions on a single chip.

VISION.

V-Series microprocessors deliver more because they incorporate NEC's total computer, communications and components expertise. Join us in the 32-bit future by taking the road that suits you best. Price or performance. You'll find them both in the V-Series.

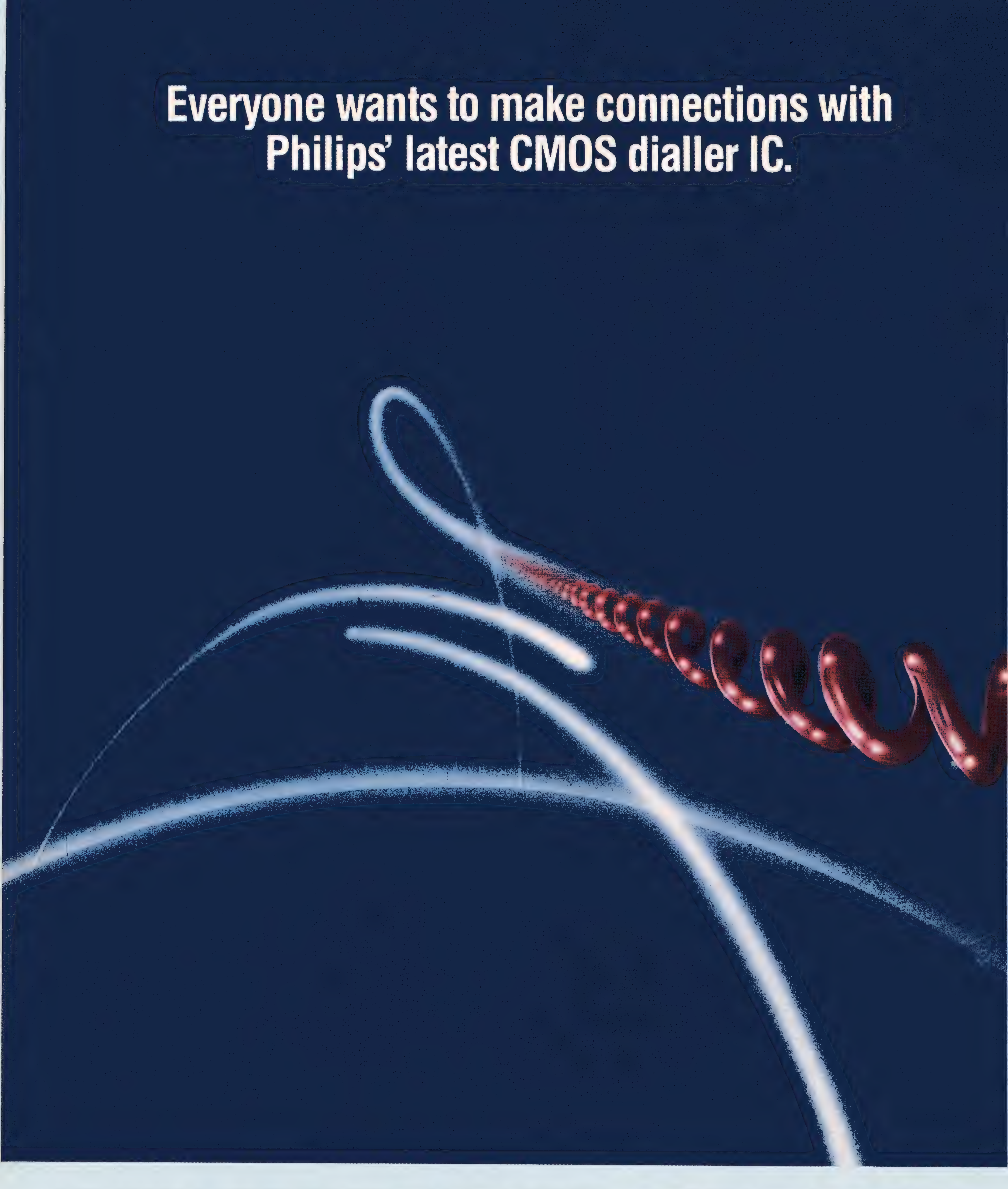
For further information, please contact:

■ **USA**	**NEC Electronics Inc.** **Tel:415-960-6000. TWX:910-379-6985**
■ **Europe**	**NEC Electronics (Germany) GmbH** **Tel:0211-650302. Telex:8589960 NE D.**
	NEC Electronics (Benelux) **Netherlands** **Tel:040-445-845. Telex:51923 NEC B NL.**
	NEC Electronics (Scandinavia) **Sweden** **Tel:08-732-8200. Telex:13839 NECSCAN.**
	NEC Electronics (France) S.A. **Tel:1-3946-9617. Telex:699499 NEC EF.**
	NEC Electronics Italiana S.R.L. **Tel:02-6709108. Telex:315355 NEC EIT I.**
	NEC Electronics (UK) Limited **Tel:0698-732-221. Telex:777565 NECUK G.**
■ **Asia**	**NEC Hong Kong Limited** **Tel:0-242-824. Telex:54561 HK NEC HX.** ***Taipei Branch:* Tel:02-522-4192.** **Telex:22372 HK NEC TP.**
	NEC Singapore Pte. Ltd. **Tel:4819881. Telex:39726 NECSIN RS.**

NEC

UNIX is a trademark of AT&T Bell Laboratories.

CIRCLE NO 94


Everyone wants to make connections with
Philips' latest CMOS dialler IC.

Argentina: Buenos Aires, Tel. 541-7141/7242/7343/7444/7545. **Australia:** Artarmon, Tel. (02) 439 3322. **Austria:** Wien, Tel. 62 91 11. **Belgium:** Bruxelles, Tel. (02) 242 7400. **Brazil:** Sao Paulo, Tel. (011) 211-2600. **Canada:** Philips Scarborough, Tel. 292-5161 / Signetics Etobicoke, Tel. (416) 626-6676. **Chile:** Santiago, Tel. 39-4001. **Colombia:** Bogota, Tel. 2 49 76 24. **Denmark:** Copenhagen, Tel. (01) 54 11 33. **Finland:** Helsinki, Tel. 17271. **France:** Paris, Tel. 43 38 80 00. **Germany (Fed. Republic):** Hamburg, Tel. (040) 3296-0. **Greece:** Athens, Tel. 9215311/319. **Hong Kong:** Kwai Chung, Tel. (0) - 24 51 21. **India:** Bombay, Tel. 4930311/4930590. **Indonesia:** Jakarta, Tel. 512572. **Ireland:** Dublin, Tel. 69 33 55. **Italy:** Milano, Tel. 2-6752.1. **Japan:** Nihon Philips Tokyo, Tel. (03) 448-5611 / Signetics Tokyo, Tel. (03) 230-1521. **Korea (Republic of):** Seoul, Tel. 794-5011.

PHILIPS

Electronic
components
and materials

Whether it's pulse or DTMF dialling, all you need now is one chip, the new PCD 3310 dialler IC from Philips. Combining the proven features of our PCD 3320 pulse dialler and our PCD 3311/12 DTMF generator, it still boasts really low current consumption. And, like the rest of our advanced CMOS dialler family, it offers re-dial and notepad facilities as standard.

But the PCD3310 has unique features too. For example, it uses switched capacitor techniques to deliver on-chip DTMF filtering that fully meets CEPT-recommendations, without extra peripheral components. Plus an on-chip reference voltage - ensuring a stable DTMF output regardless of variations in supply voltage or ambient temperature.

For over ten years, Philips have been deeply involved in electronic telephony, producing dedicated micro-controllers, chips for the speech path, pulse and DTMF dialling. In all, introducing complete concepts from simple subscriber sets and advanced feature-phones, to cordless telephones and cellular radio. And ultimately paving the way towards implementation of the ISDN.

If you want to keep pace with the latest Telecom ICs take a look at our new brochure. It's essential reading for anyone involved in the design, production or marketing of subscriber equipment.

To get your copy, contact your local Philips organisation (see below) or complete the coupon and send it to:

Philips Electronic Components and Materials
Division, P.O. Box 218,
5600 MD Eindhoven, The Netherlands.

The name is Philips. The product is Telecom ICs.

To: Philips Electronic Components and Materials Division,
P.O. Box 218, 5600 MD Eindhoven, The Netherlands.

Name

Position/Title

Company

Address

Postcode Country

Please send me the Philips' brochure on Telecom ICs 'From Pulse dialling to ISDN'.

2606/EDN/D

Malaysia: Kuala Lumpur, Tel. 77 44 11. **Mexico:** Toluca, Tel. 91 (721) 613-00. **Netherlands:** Eindhoven, Tel. (040) 79 33 33. **New Zealand:** Auckland, Tel. 605-914. **Norway:** Oslo, Tel. 68 02 00. **Peru:** Lima, Tel. 326070. **Philippines:** Makati-Rizal, Tel. 86-89-51 to 59. **Portugal:** Lisboa, Tel. 68 31 21. **Singapore:** Singapore, Tel. 35 02 000. **South Africa:** Johannesburg 2001, Tel. 614-2362/9. **Spain:** Barcelona, Tel. 301 63 12. **Sweden:** Stockholm, Tel. 08/7821000. **Switzerland:** Zürich, Tel. 01-488 22 11. **Taiwan:** Taipei, Tel. 7120500. **Thailand:** Bangkok, Tel. 233-6330-9. **Turkey:** Istanbul, Tel. 43 59 10. **United Kingdom:** London, Tel. 01-580 6633. **United States:** Sunnyvale, California, Tel. (408) 991-2000. **Uruguay:** Montevideo, Tel. 91 43 21. **Venezuela:** Caracas, Tel. (02) 239 39 31. For countries not listed contact Eindhoven, Tlx: 35000 PHTC/NL JEVMF.

PHILIPS

CIRCLE NO 95

DAISY IS ENGINEERING

BULLETIN:

SEMICUSTOM SOLUTIONS

Advances in system simulation yield substantially increased success rates in ASIC design.

FACT: Semicustom IC vendors report a 97–99% success rate for gate arrays, yet only 33% actually work when first tested in the system. Daisy's complete simulation environment improves design control and success rates two ways: First, array resimulation incorporating circuit timing modifications due to physical layout. Second, system level simulation where the array is simulated in the context of the target system. RESULTS: Substantially increased gate array and system design success rates.

Automatic gate array layout workstation reduces risk. Designers control costs, schedules, and ASIC performance.

Workstation-based layout on Daisy's MegaGATEMASTER™ gives the designer maximum control for better net routing and increased array utilization. Automatic, in-house layout reduces risk by avoiding vendor queues and reducing or eliminating iterations, assuring the designer of ASICs that are on time, on budget, and perform to specification when used in the final system.

CDI, NEC, RCA, add design-through-layout kits to the GATEMASTER™ Library.

California Devices, Inc.®, NEC Electronics Inc.®, and RCA® have each introduced automatic gate array layout design kits for the MegaGATEMASTER. Now eight ASIC vendors support physical layout on the MegaGATEMASTER, in addition to the over 55 vendors who support electrical design and simulation on Daisy workstations—and the list is growing. Designers can select from a wide "portfolio" of ASIC vendor capabilities, gate counts and technologies.

MegaFAULT: ASIC "Manufacturability Insurance."

MegaFAULT,™ Daisy's new high speed fault simulator provides the engineer with the highest confidence level in working, manufacturable silicon through reliable fault grading of test patterns required to detect potential manufacturing defects. MegaFAULT is fully integrated with Daisy design and verification tools and provides full support of ECL, CMOS, and other circuit technologies, and can also be used for fault simulations of board-level designs.

Daisy Literature Line:
1-800-556-6661
1-800-824-2385 in CA.
Department D33.

For information on Daisy's growing Semicustom Design Solutions, and the Daisy product line, call the Daisy Literature Line at 1-800-556-6661 (in California, 1-800-824-2385) Department D33, or write the Daisy Literature Line, 3606 W. Bayshore Rd., Palo Alto, California, 94303.

Trademarks: Daisy, MegaGATEMASTER, MegaFAULT—Daisy Systems Corp. **Registered trademarks:** California Devices, Inc. (CDI)—California Devices, Inc., NEC—NEC Electronics, Inc., RCA—RCA, Inc.

Sense-cell MOSFET eliminates losses in source circuit

Sensing load currents in circuits using power-MOSFET output stages usually entails inserting a resistor in the MOSFET's source circuit. Unfortunately, this sensing resistor causes power losses and adds to the FET's on-resistance. Another type of FET solves these problems by reserving a portion of its cells for sensing source current.

Warren Schultz, *Motorola Inc*

A current-mirror power-MOSFET family uses the fine geometries of, and borrows a ratioing technique from, power-IC designs. The devices use a sense-cell structure to provide lossless current sensing in discrete designs. By understanding the operating principles and the electrical characteristics of these devices—dubbed Sense FETs—you can easily incorporate effective power-device protection and low-loss load-current control in high-current systems.

A sense-cell MOSFET uses techniques employed in Smartpower ICs. Such ICs measure load current by returning one cell of a several-thousand-cell power MOSFET to an internal amplifier rather than to the source connection. The single cell is designed to carry a fixed percentage of the total load current. Therefore, the IC measures load current by running certain milliamperes into a sense resistor or current reference as opposed to running the full load current through a current-sensing resistor.

The FET provides a pinout of the individual cell for sensing purposes. **Fig 1a** is a schematic representation of the FET, which has a cell ratio of 1:n. In other words, for every sense cell, n power cells connect to the source terminal. Typically, n represents several thousand power cells.

Although the schematic representation in **Fig 1a** accurately describes the sense-cell MOSFET, it's quite cumbersome to draw. For drafting purposes, the shorthand symbol in **Fig 1b** is more convenient. This symbol conveys the idea of a single gate, a single drain, and multiple sources without the need to draw the interconnections shown in **Fig 1a. Fig 1c** shows a typical connection for the sense-cell FET. The output voltage is similar to the value you'd obtain from a source-to-ground sense resistor in conventional power-MOSFET circuits. The primary difference is that the sense-cell MOSFET reduces the current and power in the sense resistor by three to four orders of magnitude.

Ratioing is the key

The ratioing technique used in a current-mirror FET is integral to the device's operation. Assume that you have two matched MOSFETs, one of which has a source sense resistor as shown in **Fig 2.** If the voltage across

The sense cells in a current-mirror power MOSFET allow you to accurately measure the device's drain current without the need for power-wasting current-sensing resistors.

R_{SENSE} is negligible as compared with the gate-drive voltage, then both MOSFETs have approximately the same turn-on bias. If the voltage across R_{SENSE} is 200 mV and the gate receives 12V drive, you can safely assume that the sense cell and power section have equal turn-on bias.

Given this biasing equality, the models of **Fig 3** are valid. **Fig 3a** depicts a fully turned-on gate. Equal gate drive implies equal $R_{DS(ON)}$ (drain-source on-resistance) for both FETs and, as R_{SENSE} approaches 0Ω, the current divides equally between the two matched devices. As R_{SENSE} increases and becomes non-negligible, the current partition is an inverse function of the total impedance in each leg. The sense current is

$$I_{SENSE} = \left(\frac{R_{DS(ON)}}{2R_{DS(ON)} + R_{SENSE}}\right) I_L,$$

and the sense voltage is

$$V_{SENSE} = \left(\frac{R_{DS(ON)}\, R_{SENSE}}{2R_{DS(ON)} + R_{SENSE}}\right) I_L.$$

In other words, a finite value for R_{SENSE} upsets the 1:1 ratio that's inherent in the two devices, but it does so in a predictable way: The sense current is a function of $R_{DS(ON)}$ and R_{SENSE}. To carry the analysis one step further, if the equal $R_{DS(ON)}$ values are scaled in a power device in such a way that n output cells exist for each sense cell, then

$$I_{SENSE} = \left(\frac{\dfrac{R_{DS(ON)}}{n}}{R_{DS(ON)} + R_{SENSE} + \dfrac{R_{DS(ON)}}{n}}\right) I_L$$

$$\approx \left(\frac{R_{DS(ON)}}{R_{DS(ON)} + R_{SENSE}}\right) \frac{I_L}{n},$$

and

$$V_{SENSE} \approx \left(\frac{R_{SENSE}\, I_L}{n}\right) \left(\frac{R_{DS(ON)}}{R_{DS(ON)} + R_{SENSE}}\right),$$

where $R_{DS(ON)}$ is the sense cell's on-resistance.

These expressions show that the sense resistor carries the load current reduced by the cell ratio n and attenuated further by the voltage-divider relationship between R_{SENSE} and the sense cell's $R_{DS(ON)}$. The power devices' on-resistance is also directly related to the sense cell's $R_{DS(ON)}$ by the cell ratio—in other words, the power devices' $R_{DS(ON)}$ is the sense cell's $R_{DS(ON)}$ divided by n.

This ratioing between the two $R_{DS(ON)}$ values is one way to realize lossless current sensing in switching applications. Nonetheless, you can use the sense cell in

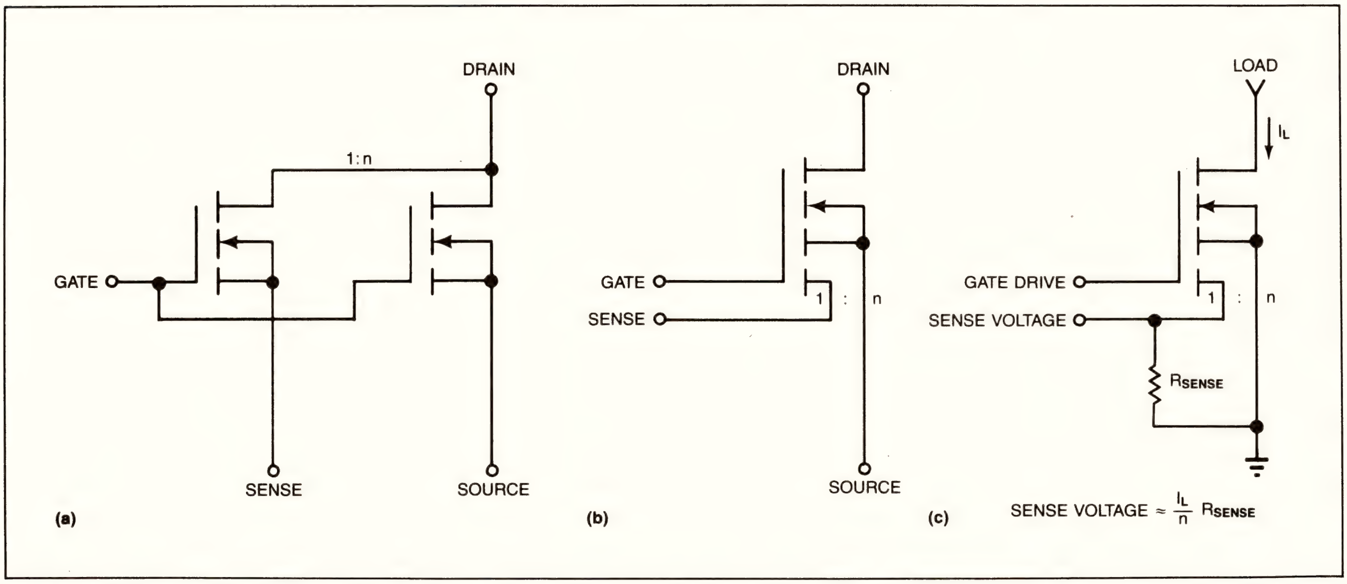


Fig 1—The symbolic schematic for a Sense FET (a) *shows that the device has n times as many power-handling cells as sense cells. The shorthand symbol in* ***b*** *is easier to draw and conveys the same information as* ***a.*** *The schematic in* ***c*** *represents a typical current-sensing application.*

another way. If R_{SENSE} is large with respect to $R_{DS(ON)}$, then ratioing ceases to be the dominant sensing mode. The sense cell becomes a switch, which, when on, applies the drain-source voltage to R_{SENSE} and, when turned off, opens up.

You can use this technique with two MOSFETs lacking sense cells. In effect, you're using the power device's drain-source resistance as the sense resistor, switching its voltage to a sensing connection when the power device is turned on, and opening the connection when the power device is turned off. This method of operation produces larger voltages, which are easier to work with, but it's not as accurate as the results that derive from ratioing. The absolute variations in $R_{DS(ON)}$ from device to device, and with temperature, are much larger than the variations in the power-section/sense-cell $R_{DS(ON)}$, which depend on matching within a monolithic device.

For class A operation (ie, the MOSFETs always conduct current), a first-order approximation to an equivalent circuit is easier to derive and understand than is the equivalent circuit for switch-mode operation. In **Fig 3b,** current sources represent the MOSFETs—an appropriate assumption for a class A model. Provided the equal-drive assumption holds, each leg conducts half the load current ($I_L/2$). Therefore, the current-sharing equations are very simple:

$$I_{SENSE}=I_L/2,$$

and

$$V_{SENSE}=(I_L/2)R_{SENSE}.$$

If you scale the model up for n output cells in a power device, the equations become

$$I_{SENSE}=I_L/(n+1)\approx I_L/n,$$

and

$$V_{SENSE}=R_{SENSE}I_L/(n+1)\approx R_{SENSE}I_L/n\ .$$

Although these equations are simpler than those that apply to switch-mode operation, the assumption that the sense voltage is negligible is often less valid. In a switched-on condition, for example, 200 mV of sense voltage subtracted from a 12V gate-drive signal will not introduce a first-order bias error. On the other hand, in a circuit that operates according to class A

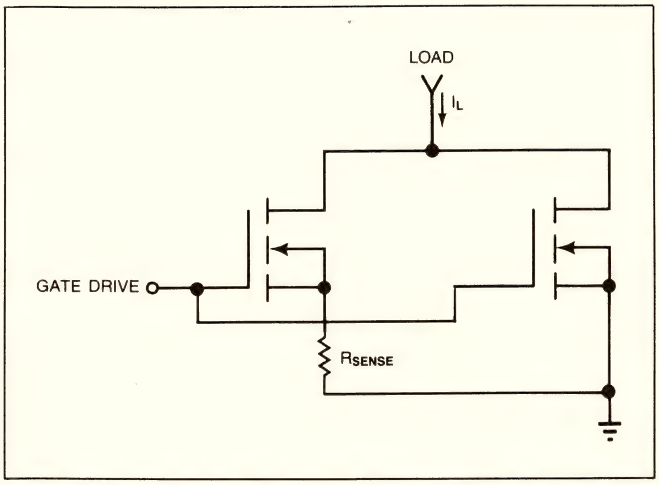


Fig 2—Assuming the voltage across R_{SENSE} is negligible *with respect to the gate-source drive voltage, both MOSFETs in this diagram have the same turn-on gate drive.*

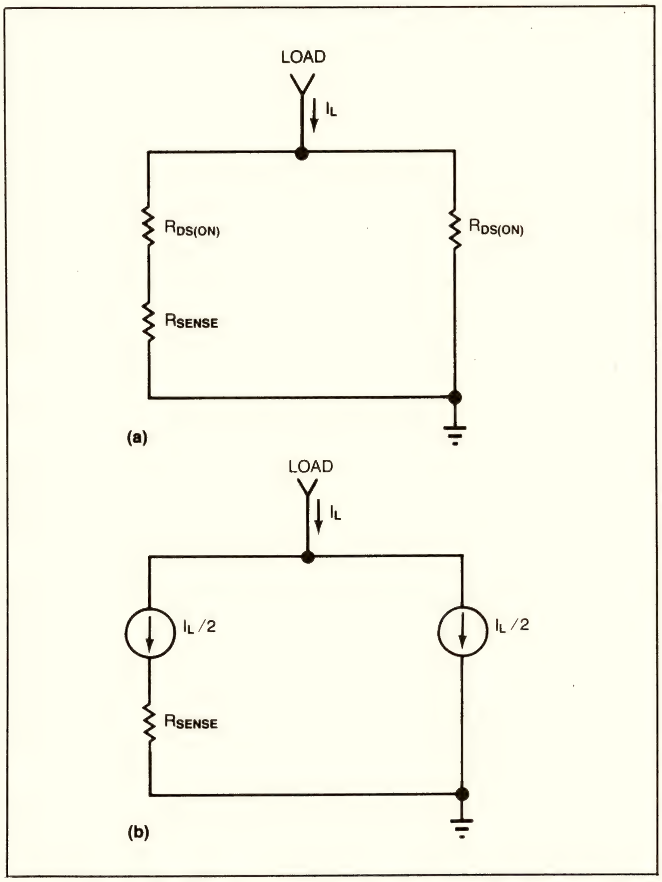


Fig 3—Based on the assumption of equal turn-on bias in Fig 2's circuit, *these equivalent circuits represent fully turned-on FETs. If R_{SENSE} is negligible, the load current divides equally between the two FETs; as R_{SENSE} increases, the current partition is a function of the impedance in each FET's source line.*

To minimize errors arising from reduced gate-source drive to the sense cells, use a sensing resistor whose value is as low as possible in the sense cells' source circuit.

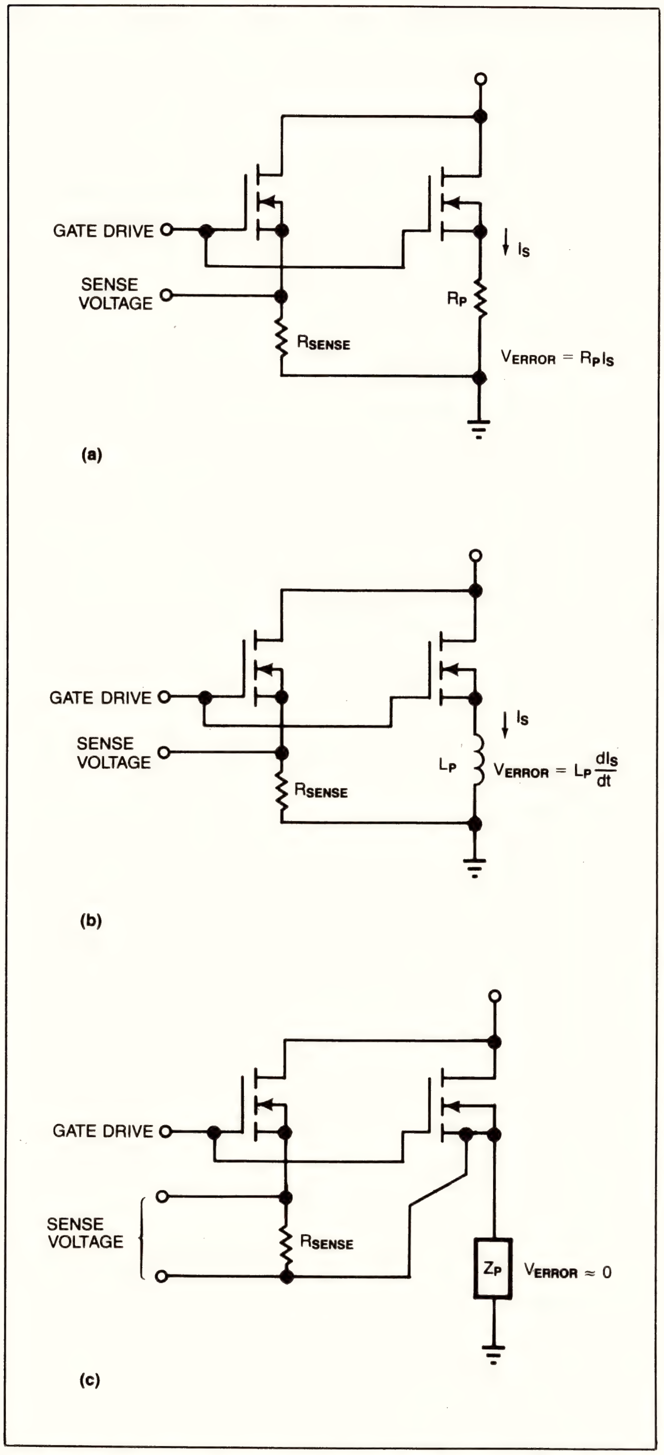


Fig 4—Parasitic elements in the MOSFET's source line *give rise to error voltages that can adversely affect the accuracy of a sensing measurement. Parasitic resistance* ***(a)*** *and inductance* ***(b)*** *are unavoidable in the source lead; however, the Kelvin connection in* ***c*** *allows you to eliminate errors by making a differential measurement.*

requirements at 1A drain current and 5.5V gate-source bias, 200 mV is an appreciable bias error. In addition, the greater power dissipation inherent in class A operation is more likely to introduce thermal effects.

Although power MOSFETs are inherently high-speed devices, sense-cell measurements are subject to various dynamic limitations. During high-speed transitions, for example, a dv/dt error signal appears (via the sense cell's drain-source capacitance) on the sense resistor. The error signal gives rise to an extra current (i=Cdv/dt), which adds to the measurement during turn-off and subtracts from it during turn-on.

An error in the opposite direction (V=Ldi/dt) also appears; this error results from high rates of di/dt that occur in the parasitic inductance in series with the power device's source. The capacitive and inductive errors aren't usually a problem when you measure current ramps or current pulses in power-conditioning circuits. They are significant enough, however, to disqualify lossless (sense-cell) current sensing as an appropriate technique for measuring power MOSFETs' switching times.

Lossless-current-sensing measurements can entail looking for, say, 100-mV signals in a loop that can carry tens or even hundreds of amperes. The potential for errors in such a situation is quite great. As illustrated in **Fig 4,** parasitic resistance **(Fig 4a)** and parasitic inductance **(Fig 4b)** in series with the source will give rise to error voltages that affect the measurement.

The way in which the error voltage affects the measurement differs, depending on whether the power device operates in its active region or switches fully on. In the active region, an error voltage at the power device's source introduces a bias imbalance, which affects the relative current sharing between the sense and power cells. When the transistor is switched fully on, bias errors aren't much of a problem, but the error voltage adds directly to $V_{DS(ON)}$ and affects the measurement proportionately.

In other words, when an error voltage is *not* present,

$$I_{SENSE} = \frac{V_{DS(ON)}}{R_{DS(ON)} + R_{SENSE}},$$

and when an error voltage *is* present,

$$I_{SENSE} = \frac{V_{DS(ON)} + V_{ERROR}}{R_{DS(ON)} + R_{SENSE}}.$$

Fortunately, eliminating this error is straightforward. Placing an extra bonding wire on the power device's source metallization (and using an additional pin) cancels parasitic voltages in the power device's source connection. **Fig 4c** shows the resulting configuration. In this circuit, you make a differential measurement across R_{SENSE}, with the aid of a Kelvin-connected source lead.

The Kelvin connection effectively eliminates the influence of parasitic impedance—including impedance internal to the power package—in the source lead. First-generation sense-cell MOSFETs use TO-220 Pentawatt packages, which provide the fifth pin needed for the Kelvin source connection.

Lossless sensing has limitations

In sensing situations in which the current-limiting control function is in a compensated linear loop, applying the lossless current-sensing technique is straightforward. However, in PWM (pulse-width modulation) systems, you must be aware of a subtle, but important, consideration. When you use lossless current sensing, you must include double-pulse suppression in the PWM-control topology. In other words, once the output current reaches the current-limit trip point, the limiting mechanism must disable the power device for the remainder of the clock period.

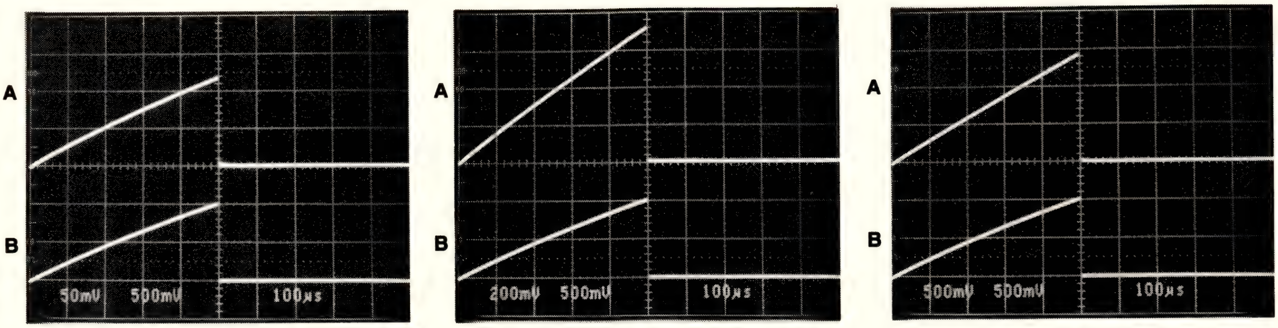
If you allow the current-limit loop to oscillate at its natural frequency, the oscillation can jeopardize the primary objective of protecting the power transistor. In systems without double-pulse suppression, the loop will often oscillate at a rate faster than the gate drive can switch the power device while holding switching losses to reasonable levels. In such systems, an otherwise foolproof protection scheme might fail because the power dissipation rapidly exceeds acceptable limits.

The importance you attach to the various factors affecting the accuracy of a current-sensing technique depends on your application. In power-conversion applications, for instance, the factors of most concern are linearity, temperature coefficient, and unit-to-unit variations in the fully turned-on sense-cell MOSFETs. As an example, consider a particular member of the Sense FET family, the MTP10N10M, a 10A, 100V device.

Fig 5 and **Fig 6** highlight the FET's linearity. These scope photos compare the sense cell's output with the voltage developed by a Pearson No 411 precision current transformer. Drain current follows a ramp from 0 to 10A in a flyback circuit, and the sense cell's source returns to ground through three values of sense resistance: 20Ω **(Fig 5a** and **Fig 6a)**, 200Ω **(Fig 5b** and **Fig 6b)**, and 2 kΩ **(Fig 5c** and **Fig 6c)**. For these scope photos, the values are an order of magnitude lower than, equal to, and higher than the sense cell's $R_{DS(ON)}$ (approximately 200Ω).

Fig 5 shows calibrated values; the sense voltage appears in trace A and the current detected by the current transformer is shown in trace B. The sense voltage corresponding to 10A ranges from 115 mV with the 20Ω sense resistor to 1430 mV with the 2-kΩ resistor.

The comparison yields more information if you scale both oscilloscope channels for equal amperes per divi-



(a)

TRACE	VERTICAL
A	50 mV/DIV
B	5A/DIV

(b)

TRACE	VERTICAL
A	200 mV/DIV
B	5A/DIV

(c)

TRACE	VERTICAL
A	500 mV/DIV
B	5A/DIV

Fig 5—The voltage developed across R_{SENSE} as a function of drain current *is shown in the A traces, as the drain current ramps from 0 to 10A. The photos depict the sensing voltage when R_{SENSE} equals 20 **(a)**, 200 **(b)**, and 2000Ω **(c)**, respectively.*

Both the linearity and the temperature coefficient of the sensing voltage are adversely affected by large values for the sensing resistor in the source line.

sion. **Fig 6** shows the superimposed traces resulting from such scaling. The single ramp in **(Fig 6a)** shows that, when $R_{SENSE}=20\Omega$, both measurements track almost perfectly. As R_{SENSE} increases, however, you can see that linearity suffers **(Fig 6b** and **Fig 6c)**, and the worst performance occurs when $R_{SENSE}=2\ k\Omega$.

Temperature stability vs R_{SENSE}

Fig 7 gives a graphic representation of the sense current's temperature stability. Again, the drain current follows a ramp from 0 to 10A. This time, each of the scope photos are double exposures: One shot was taken at 25°C, and the other was taken at 125°C. As is the case with linearity, the best results occur when the sense resistor is small with respect to the sense cell's $R_{DS(ON)}$. When $R_{SENSE}=20\Omega$, temperature tracking is essentially perfect for sense voltages as high as approximately 80 mV (or 7A drain current), and the two values diverge by only 4% at 10A.

As R_{SENSE} increases, the temperature coefficient becomes less dependent on matching and more a function of the power device's on-voltage. In the extreme case where R_{SENSE} is very large, the sense voltage approximates the power device's $V_{DS(ON)}$ and tracks this voltage's temperature coefficient. This tracking tendency is evident in **Fig 7c**, where $R_{SENSE}=2\ k\Omega$, and the two measurements diverge by 45% for a 100°C change in temperature.

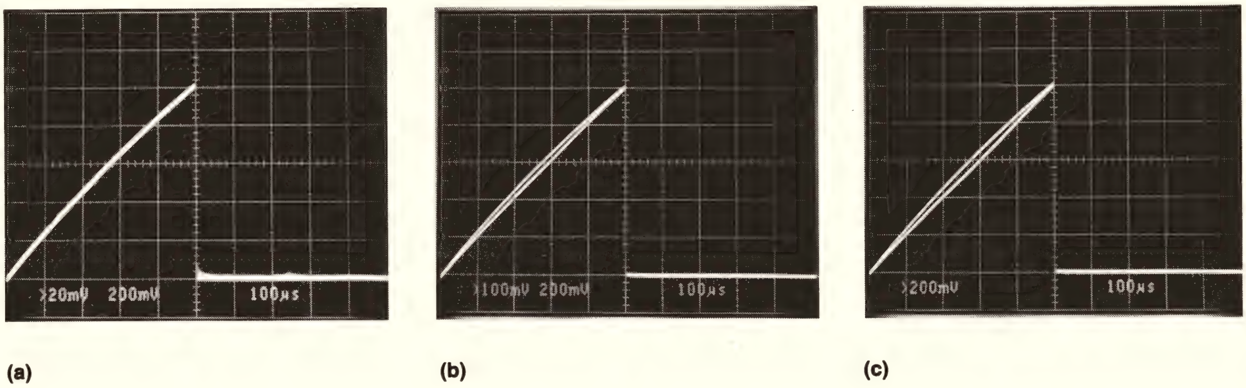


***Fig 6—Superimposing the sensing-voltage curves of Fig 5** on the drain-current curves shows an increasing departure from linearity as R_{SENSE} increases. In **a**, **b**, and **c**, R_{SENSE} is 20, 200, and 2000Ω, respectively.*

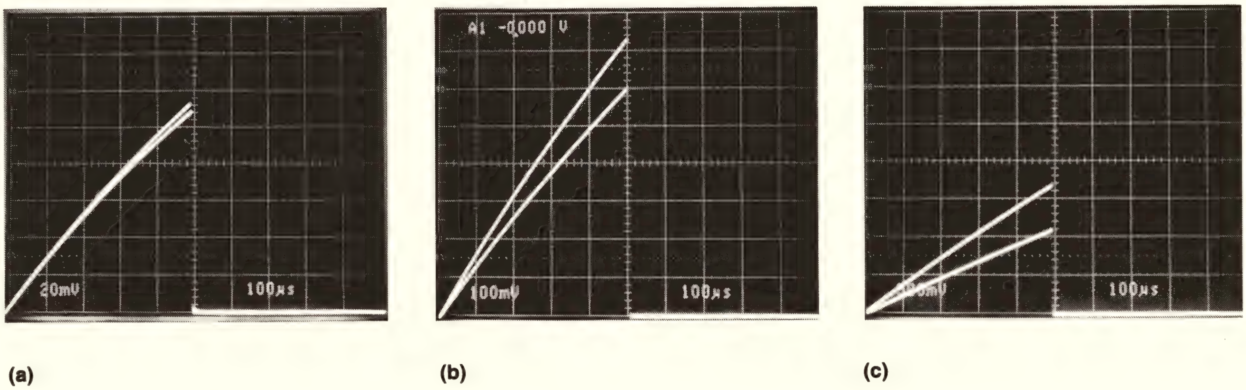
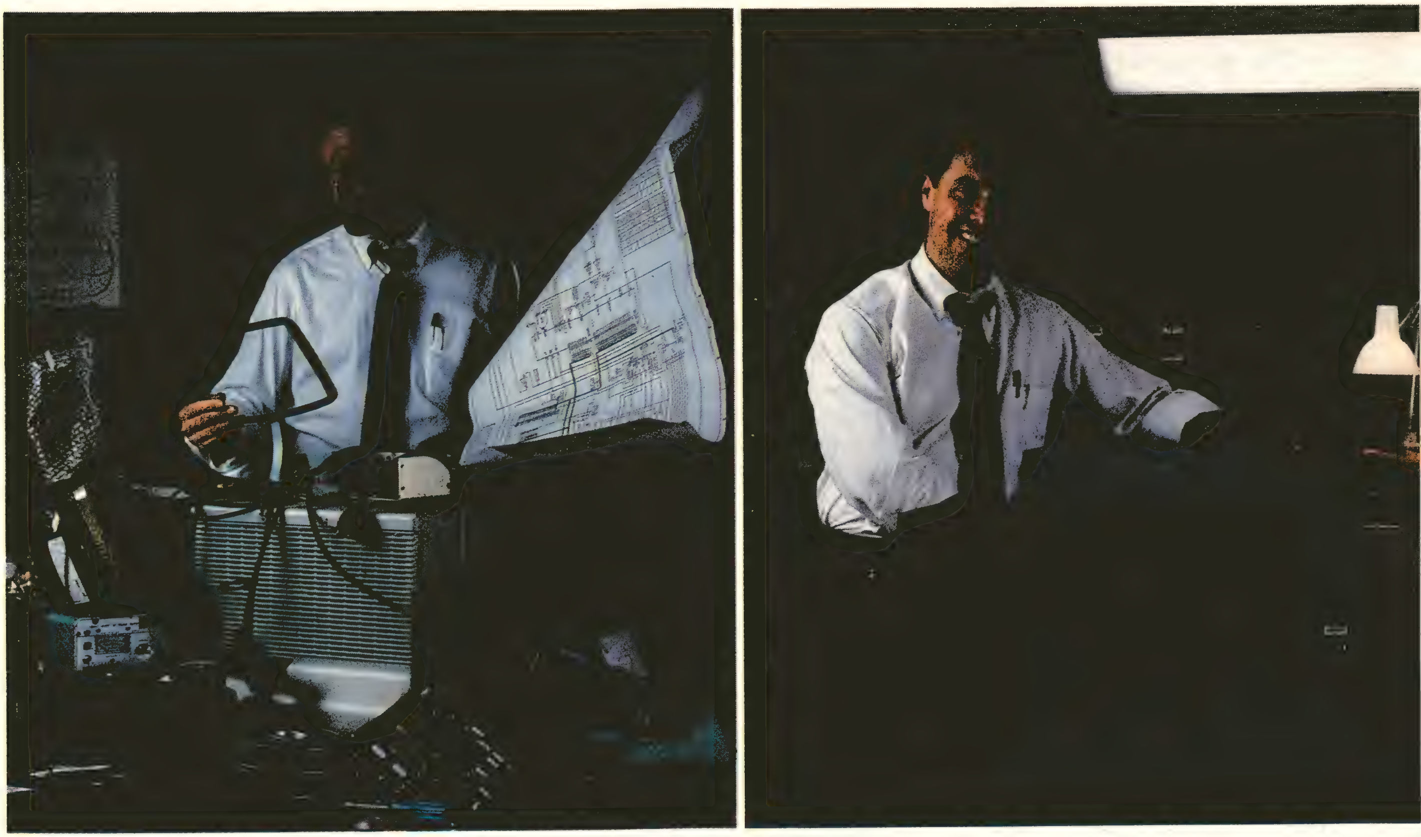


***Fig 7—As is true for linearity, temperature stability is best** for low values of R_{SENSE}. These double exposures show the sensing voltages corresponding to a drain-current ramp from 0 to 10A, at 25°C and at 125°C. In **a**, **b**, and **c**, R_{SENSE} equals 20, 200, and 2000Ω, respectively.*

Now you don't have to go to pieces to integrate touch control.



Fluke introduces the first touch control subsystem that's as easy for you as it is for your customers.

Until now there was only one way to get a touch-sensitive operator interface into your equipment. Piece by piece. By piece. That required lots of design time, not to mention lots of budget.

Now you don't have to go to pieces to enjoy the benefits of touch control. Fluke introduces the 1020 Touch Control Screen — a completely integrated subsystem. The 1020 includes touch display, CRT, power supply and logic boards. All in one compact unit. Just provide connections for power and host computer interface.

The 1020's powerful internal software helps you develop a friendly menu-driven operator interface. Unique commands simplify the creation of menus or control "buttons," so you can provide a straightforward control panel on the screen. These software aids will save you weeks of design time as you develop your operator controls.

You can specify the 1020 for the most rugged industrial environment. It's designed to meet rigorous standards for temperature range of operation, EMI protection, and safety. Resistant to chemical attack and to abrasion, the Touch Control Screen has been tested to over 1 million touch operations. Our NEMA 12 panel-mounting kit provides a seal against moisture, dirt, and contamination.

So why go to pieces when you can come to Fluke? Put the Fluke 1020 to work for you. For information on how Fluke Touch Control Screens can work in your application, call **1-800-426-0361**.

THE FIRST CHOICE
IN TOUCH CONTROL.

FLUKE 1020

CRT: 12" diagonal high contrast green phosphor
Touch cells: 12 rows × 10 columns (cover entire display)
Serial Interface: RS-232-C / RS-422-A
Baud rates: selectable up to 19,200
Seal: optional dust and moisture resistant panel mounting kit (NEMA 12)
Dimensions: 13.2" wide × 10.3" high × 12.5" deep
OEM and quantity discounts available

FLUKE®

IN THE U.S. AND NON-EUROPEAN COUNTRIES: John Fluke Mfg. Co., Inc., P.O. Box C9090, M/S 250C, Everett, WA 98206, Sales: (206) 356-5400, Other: (206) 347-6100.
EUROPEAN HEADQUARTERS: Fluke (Holland) B.V., P.O. Box 2269, 5600 CG Eindhoven, The Netherlands, (040) 458045, TLX: 51846.

© Copyright 1986 John Fluke Mfg. Co., Inc. All rights reserved. Ad No. 4602-1020

CIRCLE NO 97

Cell-ratio n provides the measure of a sense-cell FET's tolerance; present data sheets give the tolerance as ±10%, but the spec should improve as production proceeds.

The parameter governing the sense-cell MOSFET's tolerance spec is the cell ratio n. This ratio, defined as $R_{SENSE}=0\Omega$, is the ratio of source current to sense-cell current in the absence of the attenuating effect of a sense resistor. Experience to date with sense-cell FETs indicates that unit-to-unit variations in n fall well within a ±10% tolerance window.

Gaining a better idea of the ratio tolerances in sense-cell MOSFETs will require a longer production history—ie, data from distributions covering a statistically significant number of wafer lots. For present design purposes, however, you can refer to first-generation data sheets, which guarantee that the tolerance ratio spec doesn't exceed ±10%. This ±10% window doesn't allow high-precision measurements, but it yields relatively good performance when compared with other current-sensing techniques generally used for protecting power transistors.

Although the MTP10N10M is suited for power-conversion situations, a sense-cell FET isn't limited to just these types of applications. The current-sensing technique applies to most situations in which current limiting is needed in order to protect an output transistor. For example, you can use lossless current sensing in a motor drive to protect the drive from a stalled or short-circuited motor without incurring the power loss and cost of a power sense resistor.

In other applications, you can use lossless current

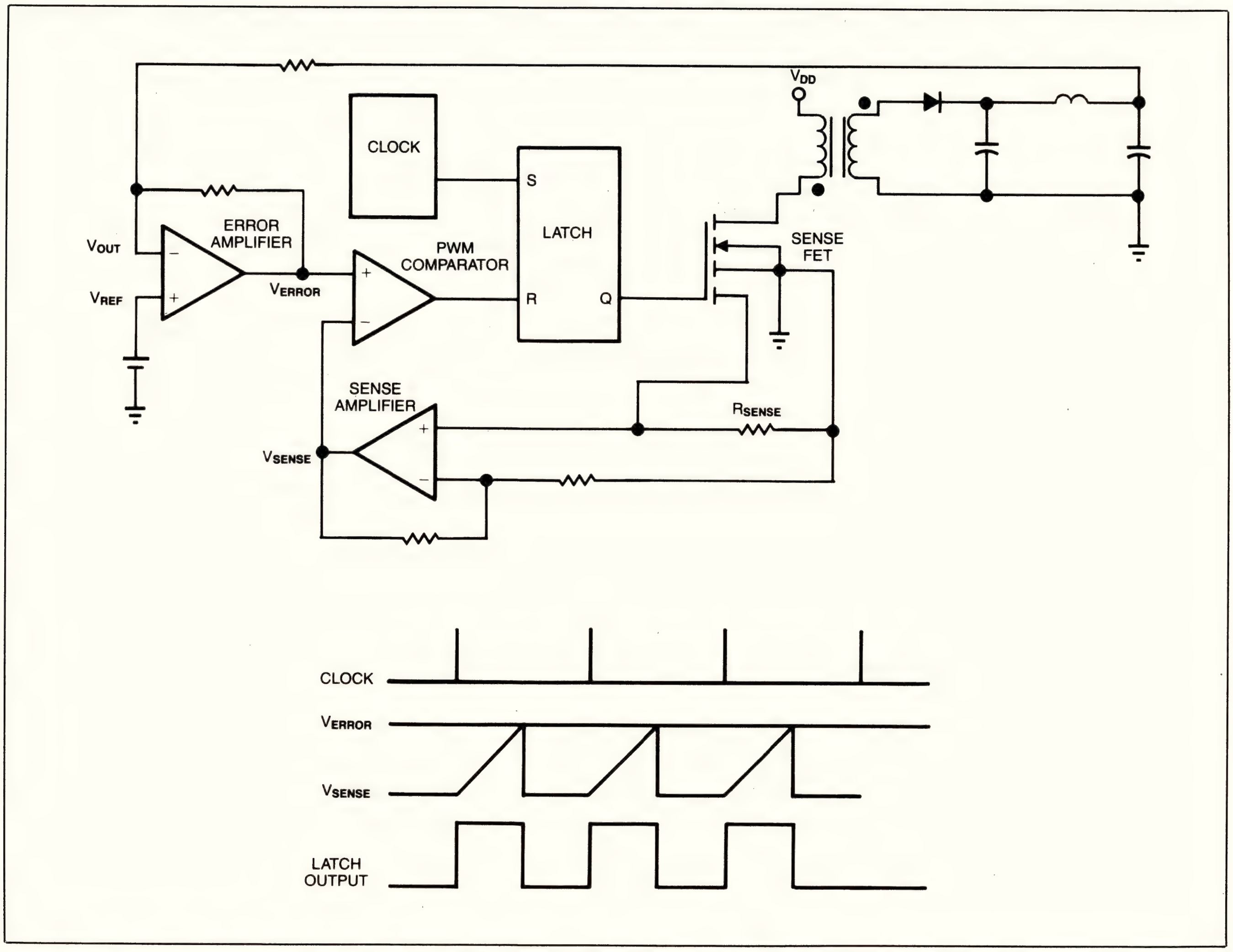


Fig 8—Using current-mode control, *this PWM supply uses lossless current sensing. The circuit employs double-pulse suppression to avoid oscillation. By using a sense-cell FET, you can avoid connecting a current-sense resistor in the MOSFET's source line, and thereby eliminate a potential source of troublesome inductance.*

A new force in power semiconductors.

There's a new name in power semiconductors.

POWEREX, Inc.

It's a joining of forces that overnight has created a new leader in the power semiconductor industry.

POWEREX is a joint venture corporation of Westinghouse, General Electric, and Mitsubishi Electric America. It combines their experience . . . their people . . . their facilities . . . their traditions of quality and reliability.

And, of course, their products . . . a broad, growing line of power semiconductors, including rectifiers, thyristors, bipolar power transistors, triacs, isolated power modules, and assemblies.

POWEREX brings a commitment to the industry to set new standards of excellence in products and service. Look for new energy in product development and application support. New products with higher switching speeds and improved efficiency. Faster responses to your delivery requirements through better inventory utilization and manufacturing processes.

POWEREX is a powerful synergy of people, technologies, and resources . . . a new force in power semiconductors.

For full information, write POWEREX, Inc., Hillis Street, Youngwood, PA 15697. Or call POWEREX headquarters at (412) 925-7272.

POWEREX

Joint Venture Corporation of Westinghouse, General Electric, and Mitsubishi.

CIRCLE NO 98

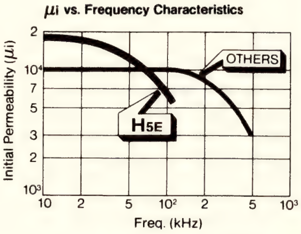
Power Your Communications. Communicate Your Power. With TDK Ferrite Cores.

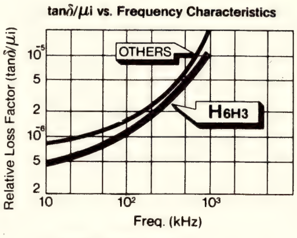
As telecom technology switches to digital, and power supplies switch to switchers, quality and features of ferrite cores take on added importance while generating new reasons to talk to the undisputed leaders, TDK.

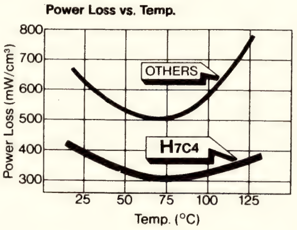
Next time you're in our neighborhood, come and take a look at the world's largest production of ferrite materials. TDK manufactures ferrite cores from the raw materials on up, with totally automated production systems. 50 years of experience and a continuous R & D program are reflected in unique features and unsurpassed quality levels.

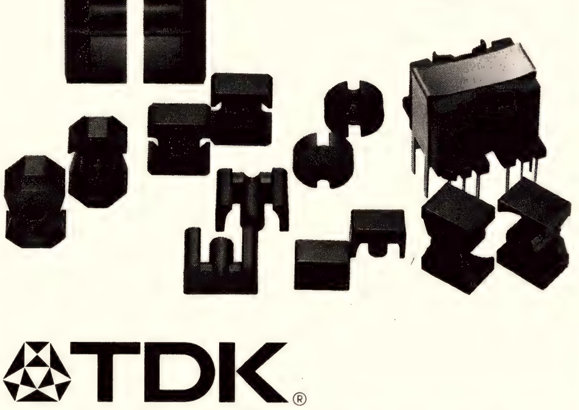
For telecom and power supply applications, TDK ferrite cores include:

- High permeability types such as our H5E
- Low loss types with significantly reduced loss factors up into the MHz range;
- Extremely low power loss and reduced temperature surge types (H7C4);
- TDK original cores, EEC, EP, LP and PQ as well as IEC standard core shapes including EEC, POT, RM, etc.









TDK®

TDK CORPORATION OF AMERICA HEAD OFFICE 4711 West Golf Road, Skokie, IL 60076, U.S.A. Phone: (312) 679-8200
TDK CORPORATION Tokyo, Japan.
MH&W INTERNATIONAL CORP. 14 Leighton Place, Mahwah, New Jersey 07430 U.S.A. Phone: (201) 891-8800
MH&W INTERNATIONAL (CANADA) LTD. Phone: (416) 676-9401

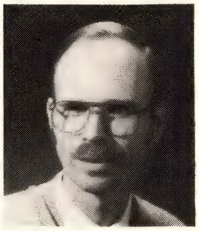
sensing to tailor peak switch currents to the needs of the load. In lamp drivers, for instance, lossless current sensing is an economical way to limit cold-filament surge current, and thereby extend the life of the lamp.

You can also tailor peak switch currents to the load by implementing current-mode control with a sense-cell FET. **Fig 8** gives an illustration of a system that uses a current-mode topology. In this circuit, the sense resistor R_{SENSE} generates the PWM ramp voltage as current ramps up in the transformer's primary. A sense amplifier then scales the ramp and feeds it to a PWM comparator. When V_{SENSE} exceeds V_{ERROR}, the power switch shuts off until the latch resets with the next clock pulse; the cycle then repeats.

The topology of the system in **Fig 8** uses double-pulse suppression; it's therefore consistent with the sense-cell FET's requirements. The circuit also benefits from the FET's lossless current-sensing technique. As compared with the conventional method of using a power sense resistor in series with the power device's source, the lossless method offers several advantages.

The most obvious benefits are power efficiency and lower cost for the sensing element. Moreover, at higher operating frequencies the lossless current-sensing approach offers a more subtle advantage in that it minimizes parasitic inductance in the source lead. Source inductance is the most troublesome kind of parasitic inductance at high switching speeds, and the addition of a series sense resistor can introduce unwanted dynamic limitations. The sense-cell approach removes these limitations by providing a direct ground connection to the source lead. **EDN**

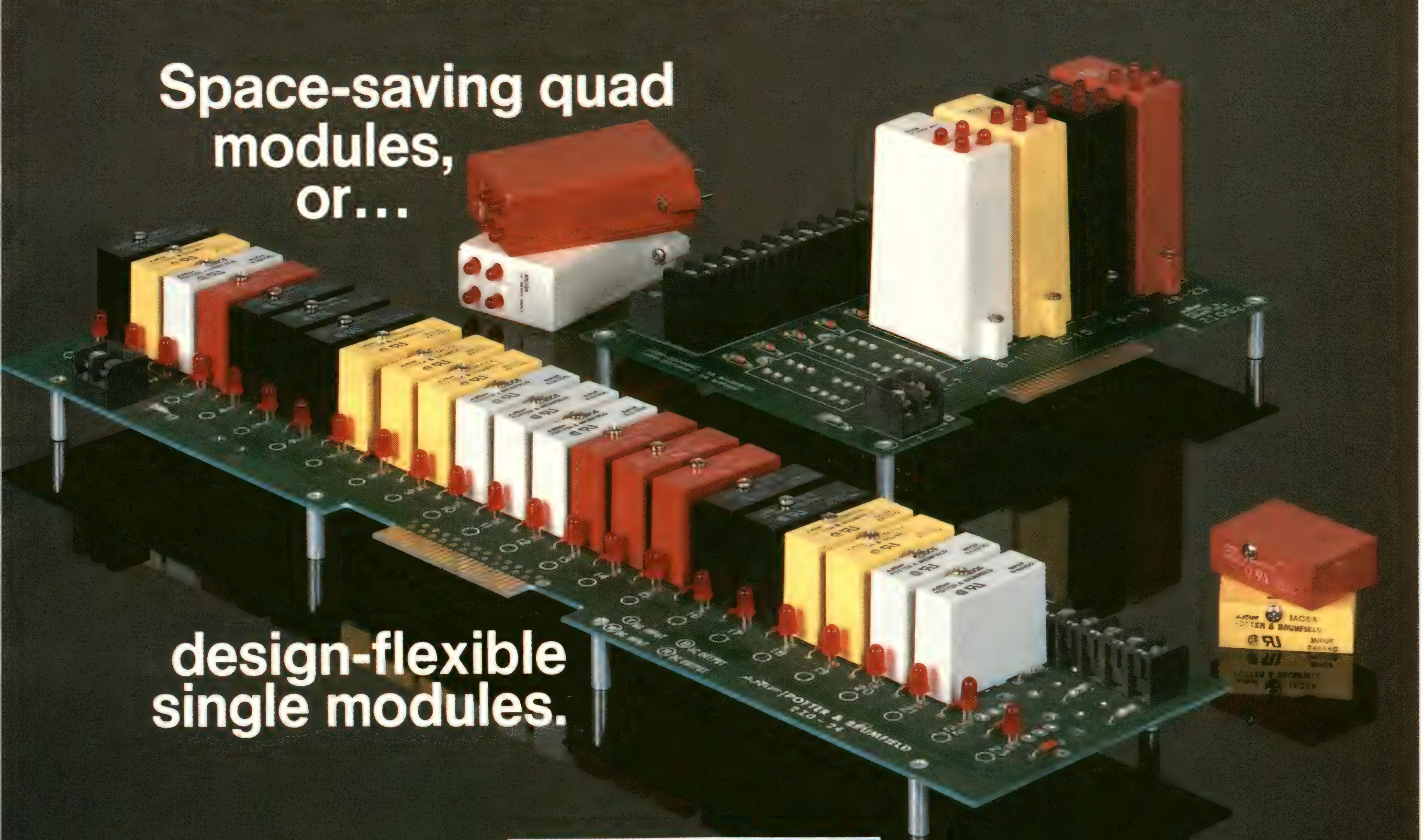
Author's biography

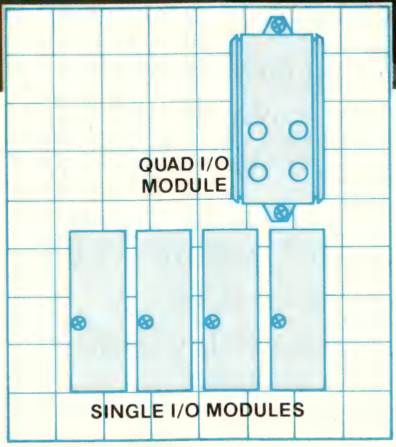


Warren Schultz is principal engineer in the low-frequency power-transistor and thyristor division at Motorola (Phoenix, AZ). Previously employed by GE Aerospace, he's been with Motorola for 14 years. Warren holds a BSEE from Lehigh University and an MBA from Arizona State University. He's been granted one patent, and three more are pending, for his work with Motorola's Smartpower technology.

Article Interest Quotient (Circle One)
High 476 Medium 477 Low 478

P&B offers you the I/O options you need!


Space-saving quad modules, or…
design-flexible single modules.
POTTER & BRUMFIELD



P&B's compact, quad input/output modules are perfect for your industrial control applications with limited space available for interface devices. Each quad module has four I/O channels in a single, plug-in package. An LED indicator is provided for each channel, and modules are color-coded by function.

For designs requiring even more flexibility, our single I/O modules provide single channel pluggability in four photo-isolated, color-coded versions.

Both types reliably interface microprocessor- or computer-based systems with "real world" input devices and loads. Models for use with 5, 15, and 24 volt DC logic systems are in stock. And they have advanced features which many competitors' units lack.

All our I/O modules are highly immune to EMI-induced false operation. They withstand noise levels greater than 3,000 volts, peak-to-peak, without false operating, per NEMA ICS 2-230 (Electrical Noise Immunity Test). This minimizes load half-cycling and helps keep false signals out of the logic system.

Plus, P&B I/O modules are series operation compatible. Input and output modules are fully compatible, so a series-connected input module turns off when the output module turns off—ideal for load-monitoring applications.

We also offer a complete line of mounting boards for single and quad I/O modules. All are UL recognized and CSA certified.

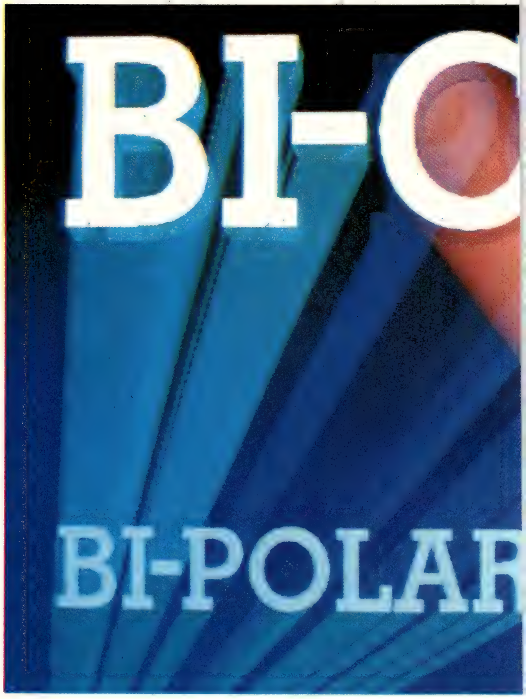
Find out more about P&B I/O products. For the name of your nearest authorized stocking distributor or sales representative, call toll-free **800/255-2550.** Potter & Brumfield, A Siemens Company, 200 S. Richland Creek Drive, Princeton, IN 47671-0001.

Regional Sales: Oak Brook, IL, 312/887-0811; Braintree, MA, 617/848-6550; San Juan Capistrano, CA, 714/493-4503; Princeton, IN, 812/386-2130.

Potter & Brumfield

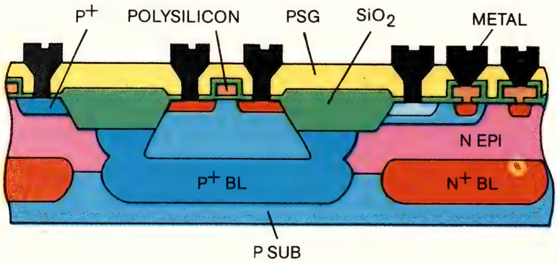
CIRCLE NO 100

Leading
BI-CMOS



NEC's revolutionary BI-CMOS Gate Array puts an end to compromise solutions. NEC have combined the two major gate array technologies to give you the best of both worlds: the high speed and driving capability of bipolar arrays and the low power consumption associated with CMOS technology.

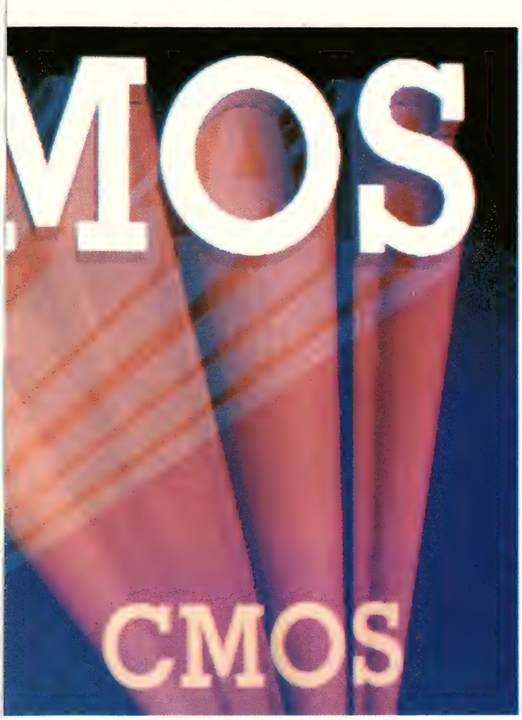
High speed is a standard feature with up to 160 MHz operation, 0.45 ns internal gate propagation delay time (fan out of 1) and power dissipation per internal gate of only 18 μW/MHz. The gate array family consists of four masters with gate counts between 623 and 3140 and up to 140 I/O buffers with a maximum of 24 mA sink capability per output.



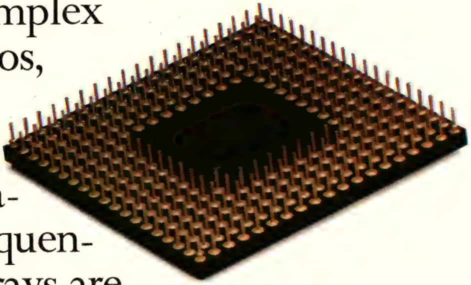
A new process technology specially developed for the BI-CMOS Gate Array production uses a high resistivity epitaxial layer combined with n- and p-type buried layers to eliminate the latch-up effect.

NEC's new BI-CMOS Gate Array family is the latest in a long tradition of high performance ASICs that include 1.5 μ CMOS gate arrays

the field
Gate Arrays



with packing densities of up to 20,000 gates, standard cell ICs with the provision of highly complex on-chip megamacros, and super-fast gate arrays in ECL technology for gigahertz operating frequencies. NEC's gate arrays are backed up by professional design centres throughout Europe working with sophisticated hardware and software systems to ensure fast and trouble-free design implementation. NEC fully supports Daisy Systems, Valid, Mentor, and Micad engineering workstations and utilizes simulation and software tools such as Hilo, Silvar Lisco and Future Net.

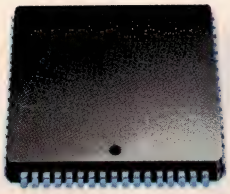


West Germany: Düsseldorf 02 11/65 03 01, Telex 8 58 996-0
The Netherlands: Eindhoven 0 40/44 58 45, Telex 51 923
France: Paris 01/39 46 96 17, Télex 699 499
Italy: Milano 02/67 09 108, Telex 315 355
Sweden: Täby 08/73 28 200, Telex 13 839
UK: Motherwell 06 98/73 22 21, Telex 777 565

NEC

CIRCLE NO 101

SIEMENS



Everything y
to know about S
find out about it
where you see t

SMD, surface mounting, automatic placement systems – keywords that stand for the modern production of printed circuit boards. The components are directly soldered onto the circuit board and no longer inserted. The benefits are compelling:

- smaller boards,
- higher packing density,
- more rationalized production,
- higher reliability.

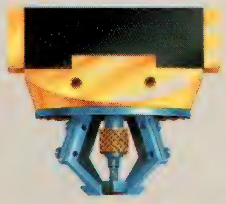
But what do you have to watch out for when changing your production line to SMD? What are the precise advantages you get out of it? Are there automatic placement systems that are really right for your needs? What's the most suitable soldering technique? What should the layout for the circuit boards look like? What surface mounted devices are already available? They're all questions whose answers determine the economy and profitability of your production process. We have complete documentation ready and waiting for you about:

- our broad spectrum of SMD designs in all conventional package sizes,
- our proven-in-practice, flexible automatic placement systems for small and medium lots,
- the use of SMD technology in our own products.

And if you really want to get the picture, ask for our "SMD" video cassette.

Just send off the coupon. And as soon as things start to take on concrete shape, we'll be glad to advise you personally.

CIRCLE NO 104

u ever wanted
ID  –
rom Siemens
is sign SMD

EDN62686

Info retrieval

☐ Send me free of charge your information package about SMD and Siemens.

☐ Send me free of charge and on loan your VHS/PAL video cassette "SMD" (18 min duration).

Return the coupon to:
Siemens AG
Infoservice 12/Z 003 e
Postfach 2348
D-8510 Fürth
West Germany

✂ request separate

12/Z 003 e

Why Ando's "New Generation" VLSI Testers Are Better

- 100MHz Speed
- 1024-Pin Testing
- Dual CPU Architecture

In the face of today's advances—like higher pin counts, faster speeds, application-specific ICs and the like—you can't afford to be left behind. That's why Ando has created our new DIC-9000 series of VLSI test systems.

They're Fast, They're Capable

With test speeds up to 100MHz and simultaneous testing of up to 1,024 I/O pins, these testers are ready for the most sophisticated R&D lab. They're also ideal for the inspection or production line, too.

They Link Up

The dual 32-bit CPU architecture means DIC-9000-series testers can be easily linked to CAD or factory automation systems, guaranteeing the utmost in overall throughput.

They Get Down to Business

Leading off is the DIC-9035 VLSI Test System, featuring testing of a full 512 I/O pins with ±500ps accuracy. Three different types of stations are available for testing high-pin-count gate arrays and scan-design ICs; high-speed MPUs up to 32 bits; ECL and GaAs; the list goes on and on. Dual CPUs, DC/pin architecture and parallel testing mean better performance and throughput, too.

Want to hear more about this remarkable new generation? Contact your nearest Ando sales office. Or better yet, come see us at Semicon West.

The DIC-9035 VLSI Test System

Test Rate 100MHz (link mode)
50MHz (normal mode)
Pin Count 512 I/O pins, 256 I/O pins, or 128 I/O pins
Test Stations General-purpose station (Driver: 12Vp-p)
Bipolar station (Driver: 2.5Vp-p, Comparator: −3 to +5V)
Low capacitance station (Driver: 7Vp-p, Input capacitance: 30pF)
Total Timing Accuracy ±500ps
Timing Generator 46 edges max.
Pattern Memory 512k words max.
Algorithmic Pattern Generator* 14X, 14Y, 18 data
Serial Pattern Generator* 1CH × 8M words to 32CH × 256k words
DC Measurement Universal type; 16 units/station; PMU/pin
Parallel Testing Available

*ALPG and SPG output can be connected to any tester pin via pin selector.

ANDO
ANDO CORPORATION

480 Oakmead Parkway, Sunnyvale, CA 94086 Phone: (408) 738-2636 ■ 7617 Standish Place, Rockville, MD 20855 Phone: (301) 294-3365

CIRCLE NO 105

CRT display circuit eliminates need for controller chip

A bit-mapped CRT display doesn't necessarily require a complex controller chip. A μC chip and a dual-port video-RAM chip form the core of a simple display-controller circuit.

David Davidian, *NEC Electronics Inc*

You can build a bit-mapped alphanumeric display controller from a μC chip, a video-RAM chip, and 12 logic chips. The μC chip controls the display's timing, processes incoming characters, and updates the display's data. The video-RAM chip stores pixel images of the display characters and transfers the pixels to a 640-column×250-row monitor or CRT display. Because the video-RAM chip contains a serial register that lets it quickly address rows of display information, the circuit doesn't require a CRT controller chip.

In the simplified design of such a display controller **(Fig 1)**, a μPD7811 μC chip provides overall control of the timing one-shot, or monostable, circuits that generate the necessary synchronization and signals for the CRT display and signals, which control the μPD41264 video RAM. The μC also controls the flow of character data to and from the dual-port RAM chip.

In a traditional alphanumeric display, the controller

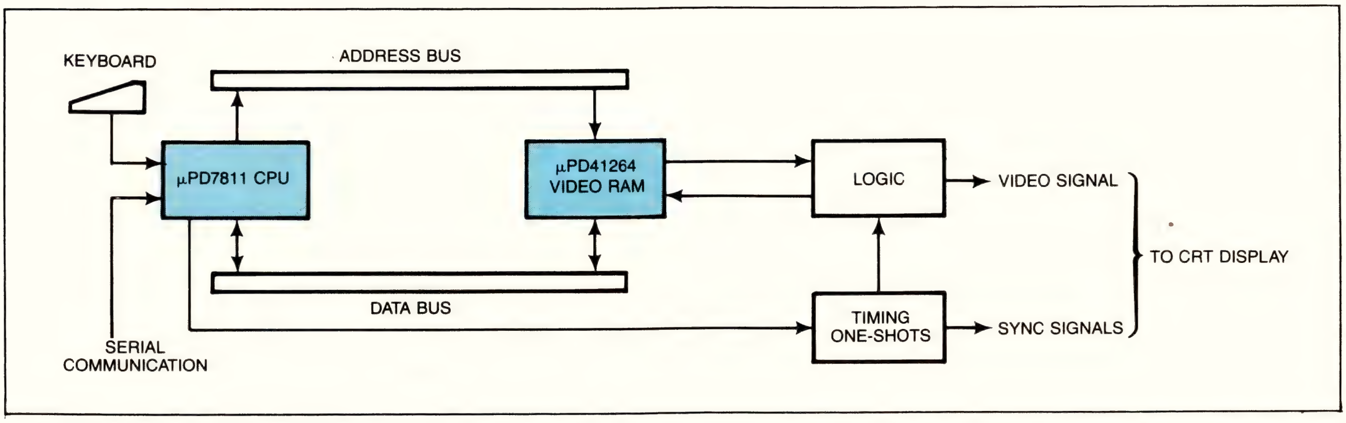


***Fig 1—A block diagram of the controller** shows the μPD7811 μC and the μPD41264 video-RAM chips. The address and data buses are local and aren't available for expansion of the circuit.*

circuit addresses predefined character patterns in ROM. Additional circuits shift the ROM's output bits to a monitor or CRT, which displays the character's pixels.

A bit-mapped display is different. Instead of addressing bit patterns in a ROM chip, it requires a memory map whose bits duplicate the information on the display screen, one bit for each pixel. When the controller receives an ASCII value, the μC's program treats the value as a pointer that locates the corresponding character's pixel image in the system's ROM. The controller transfers character images from ROM into the video RAM, which then transfers the bits to the display. Instead of displaying the ROM's data directly, the program displays an image of the memory's bits. Bit-mapped display systems let the controller manipulate individual bits, thus letting you display high-resolution graphic images in which you can mix text.

The μC and video-RAM chips provide the nucleus of the display-control circuit. The μPD7811 furnishes 40 I/O port lines, a full-duplex USART, a 16-bit timer/counter, and two programmable 8-bit timers. However,

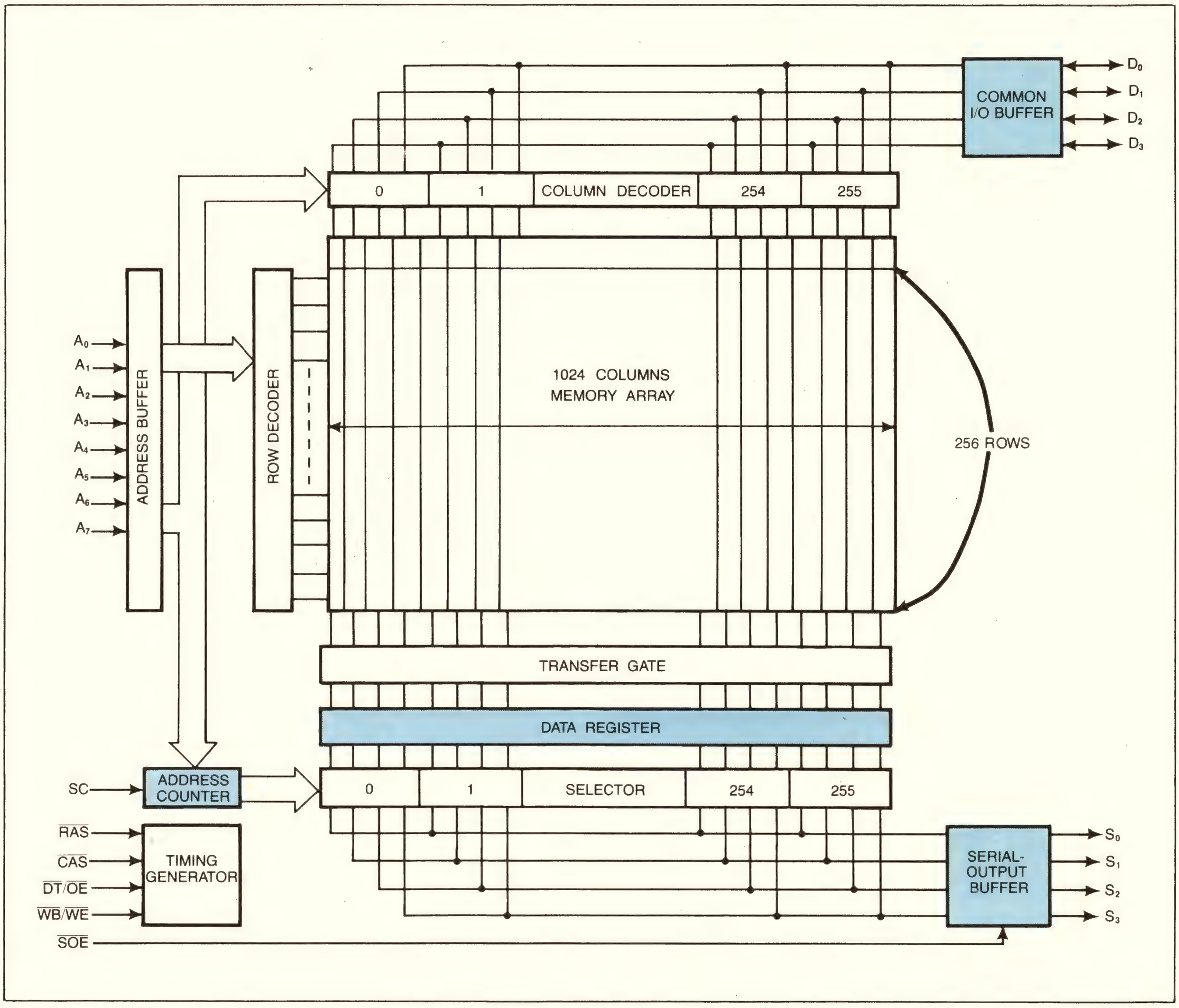


Fig 2—The video-RAM block diagram *shows the memory's organization. The display screen's pixel width and height are subsets of the RAM's 1024-column×256-row organization.*

The basic display controller requires only 14 ICs to portray characters on a CRT screen.

the prototype CRT controller uses a μPD78PG11 chip, which is a basic μPD7811 μC but has a 28-pin piggyback PROM socket on its top. The PROM socket provides a convenient means of substituting an external 4k-byte PROM for the chip's internal 4k-byte masked ROM. Also, by connecting the memory to the CPU through the piggyback PROM socket, you eliminate the need for extra memory-address and -data buffers as well as address-decoders.

Video RAM selects data

The page-mode access and refresh-timing operations of the μPD41264 video-RAM chip make it operate like a standard 64k×4-bit dynamic RAM. Besides storing 256k bits of data, the video-RAM chip contains a data register that holds 256 4-bit values **(Fig 2).** When you apply a clock signal to the RAM's serial-clock (SC) input at pin 1, the chip sequences through the 256 4-bit values one at a time, providing the data bits at output lines S_0 through S_3. The SC signal controls a counter that sequentially selects the 4-bit values. During most of its operations, the video RAM's memory and serial register operate asynchronously.

It's only necessary to synchronize the D_0-D_3 lines and the S_0-S_3 outputs during a data-transfer cycle (ie, when the chip transfers data from its memory array to its data register). The data-transfer cycle resembles a standard dynamic-RAM access cycle, except that the chip's row address locates the row position of the information going to the data register. Likewise, the chip's column address presets the address counter, so you can select which 4-bit value in the register is output first.

In the video RAM, the row address corresponds to the row of video information on the display screen while the column address selects the starting column position on the screen. The column and row values let you select information in the video RAM that corresponds to the display screen's pixel map. You must keep in mind that the video RAM addresses nibbles rather than bits or bytes of data.

If the video RAM's data-transfer signal, $\overline{DT}$, is a logic zero when the chip's $\overline{RAS}$ input goes to a logic zero, the chip performs a data-transfer cycle. The rising edge of the $\overline{DT}$ signal causes the transfer to take place. The $\overline{DT}$ signal shares the same pin with the output-enable signal, $\overline{OE}$. The video-RAM chip updates the serial register in one pixel-display cycle while the screen is active.

In addition to controlling the video RAM and the external timing monostable circuits, the CPU accepts ASCII-encoded character information from either an external keyboard connected to port A or from its internal USART. The CPU polls the internal USART and the keyboard-input port and obtains any waiting data during the display's vertical-retrace time.

As it processes each incoming character, the CPU must also check and update the screen-position, end-of-screen, and end-of-line variables, which it stores in its internal RAM. Because the software requires 35 μsec to process each incoming character, the CPU suppresses the horizontal-sync signal until it writes the character's image into the video RAM and updates the screen pointers and variables. Depending on the type of monitor you use, you may observe a flash on the screen whenever the CPU processes a character entered via the keyboard or USART.

Processing incoming characters and managing the memory and the control circuits doesn't require a long program. In this particular CRT-display circuit, the μC chip's internal 256-byte RAM and the 4k-byte piggyback PROM furnish sufficient memory. Thus, instead of using the μC chip's port D and port F lines to expand the μC's program and data memory-address range, you can use the ports for general-purpose I/O operations.

In the video-controller circuit **(Fig 3),** port F supplies video-RAM row addresses to the 74LS257 multiplexers while port D provides column addresses. The ports provide most significant and least significant nibbles to the multiplexers. The circuit and the μC's software treat the video-RAM chip as a peripheral.

The μC's port B bits PB_0 through PB_3 transfer data to the video-RAM chip, and bits PB_4 through PB_7 control three one-shots and a 7486 exclusive-OR gate. The exclusive-OR gate controls the RAM chip's output-enable or data-transfer operation; ie, you can choose whether you're writing data into memory from the μC or transferring data from memory to the serial register.

Master clock controls timing

The control circuit relies on a 22.1184-MHz crystal oscillator for all timing operations. The oscillator drives a 74LS163 counter, which in turn generates an 11.592-MHz pixel- or dot-clock signal that controls the μC chip and synchronizes the video output signals, +HSYNC, −VSYNC, and VIDEO. The 74LS163 counter chip also generates the video RAM's shift-clock (SC) signal. A flip-flop synchronizes SC with the 22.1184-MHz signal to generate a parallel-enable signal for the 74LS195

Text continued on pg 190

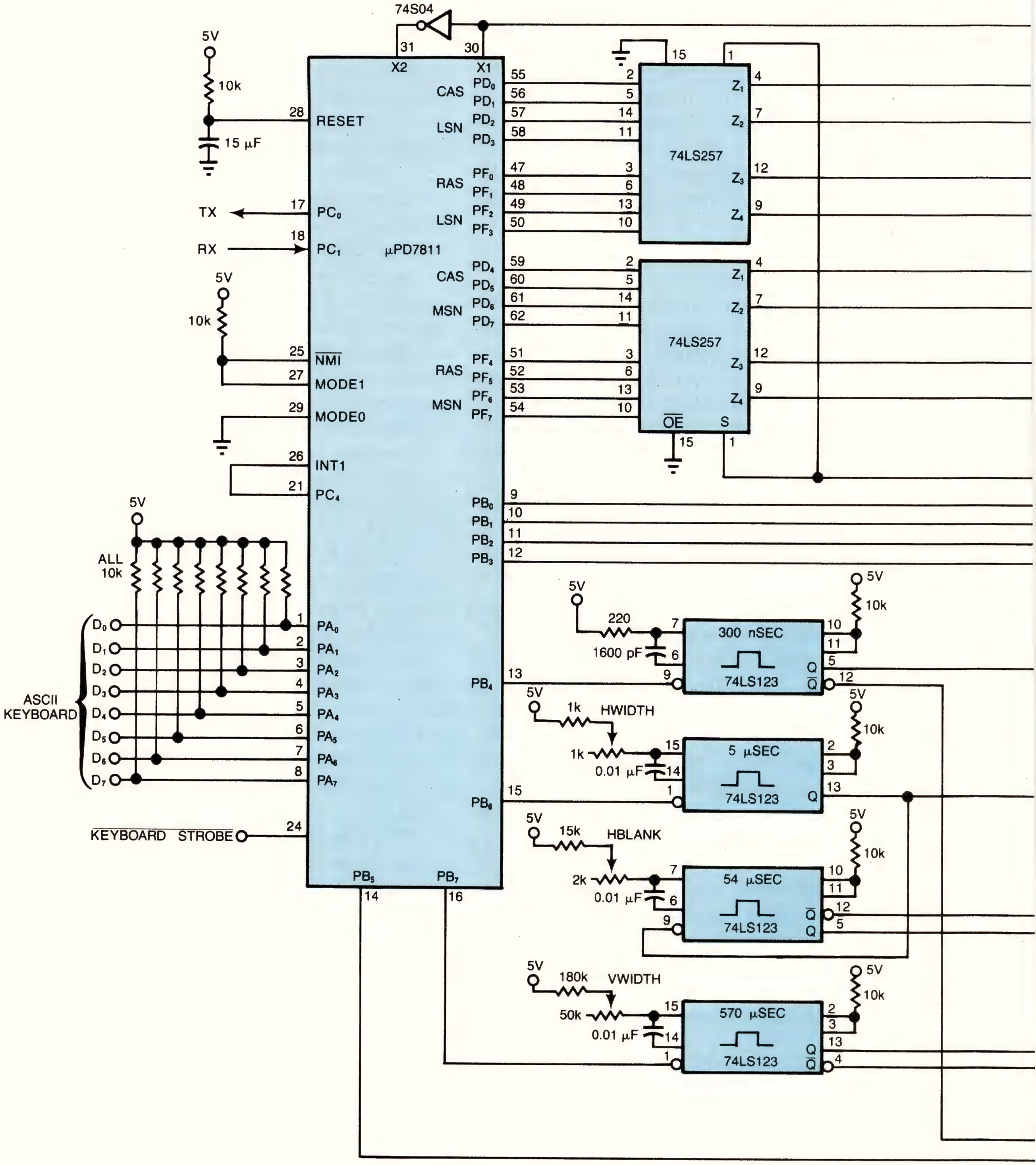
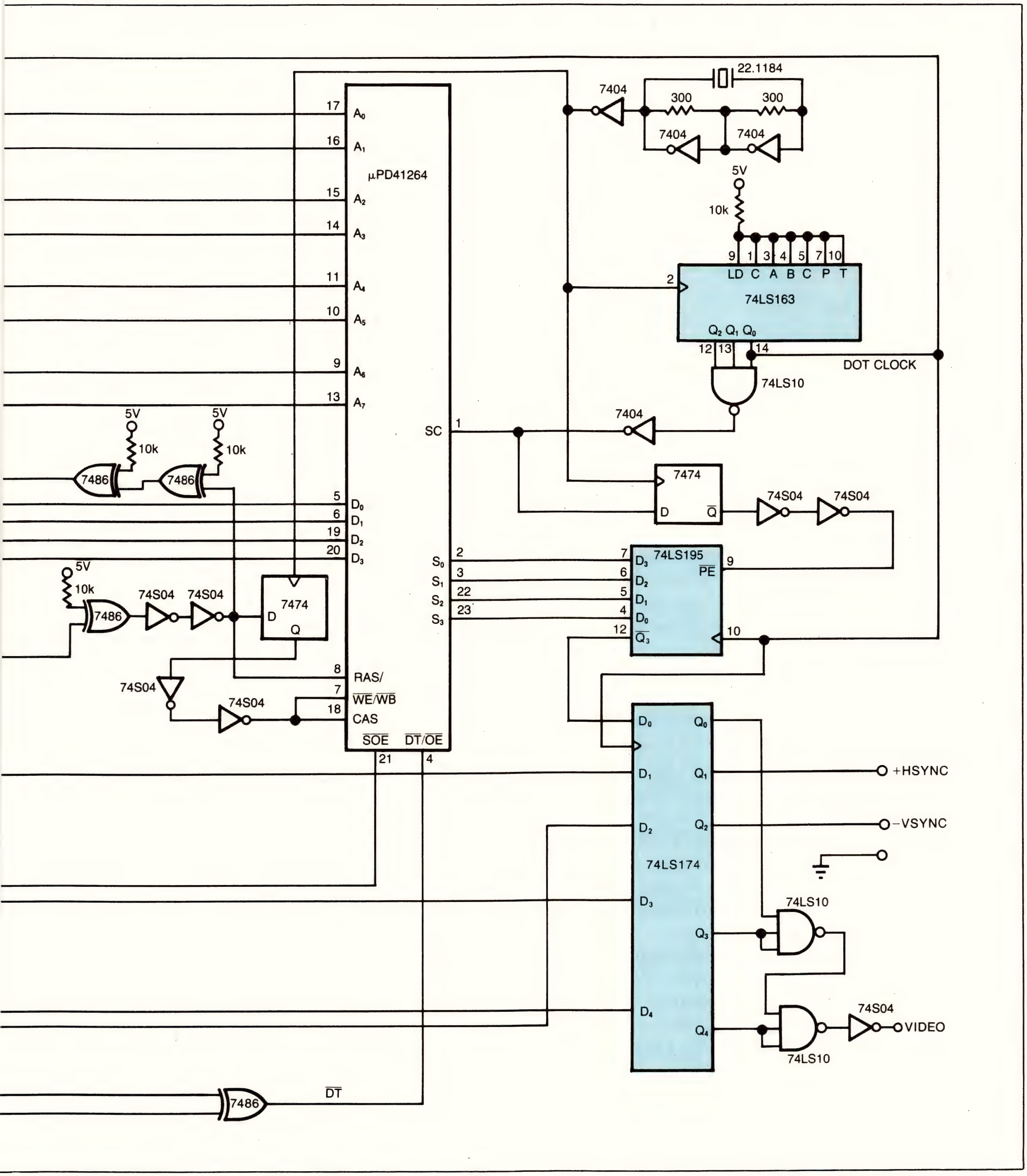


Fig 3—The display controller's circuit *requires only 14 ICs to display alphanumeric characters on a CRT display. The controller accepts data from a parallel ASCII keyboard or from the µC's internal USART.*


µPD41264
17 A0
16 A1
15 A2
14 A3
11 A4
10 A5
9 A6
13 A7
5 D0
6 D1
19 D2
20 D3
8 RAS/
7 WE/WB
18 CAS
SOE
DT/OE
21
4
SC 1
S0 2
S1 3
S2 22
S3 23
22.1184
300
300
7404
7404
7404
7404
5V
10k
9 1 3 4 5 7 10
LD C A B C P T
2
74LS163
Q2 Q1 Q0
12 13 14
74LS10
DOT CLOCK
7404
7474
D
Q
74S04
74S04
74LS195
7 D3
6 D2
5 D1
4 D0
12 Q3
9 PE
10
5V
10k
7486
5V
10k
7486
5V
10k
7486
74S04
74S04
7474
D
Q
74S04
74S04
74LS174
D0 Q0
D1 Q1
D2 Q2
D3 Q3
D4 Q4
+HSYNC
−VSYNC
74LS10
74LS10
74S04
VIDEO
7486
DT

The RAM chip stores video images instead of ASCII codes.

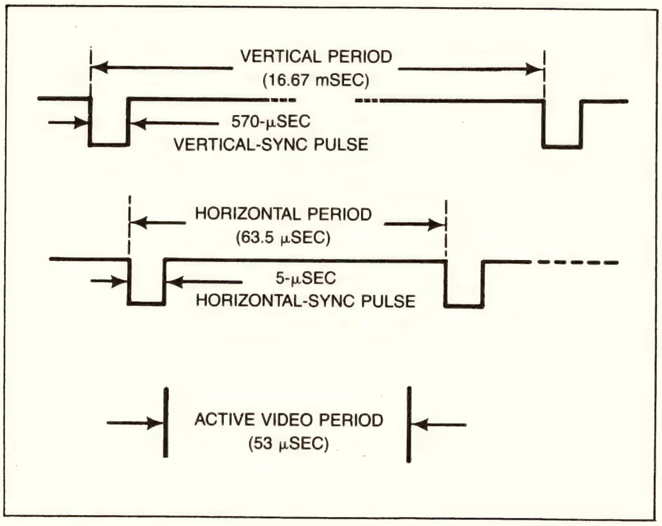


Fig 4—The controller's video-timing signals *conform to the NTSC RS-170 specifications for monitor-type displays.*

shift register, which transforms the RAM's 4-bit parallel output into a serial bit stream for the display.

The 11.592-MHz signal also drives the 74LS195 chip's clock input, and it serves as the time base for the μC's internal USART. When you divide the clock signal by 384 in an internal counter, the resulting clock signal operates the USART at 1800 bps.

To provide the controller's horizontal-retrace timebase—the display's basic timing unit—the software programs the μPD7811's timer 0 for a 64-μsec period. The circuit connects the timer 0 output to the INT1 interrupt input on the μPD7811 chip, thus generating a regular interrupt that controls the display- and character-processing software. Within the interrupt-processing routine, the μC triggers a 74LS123 one-shot that generates a 5-μsec horizontal-sync signal. A 74LS174 flip-flop synchronizes the 5-μsec pulse with the dot-clock signal to generate a horizontal-sync pulse, +HSYNC, for the display.

As part of the horizontal-retrace interrupt software, the CPU performs a data-transfer cycle, during which the video RAM transfers information from its memory array into its data register. The transfer provides the next row of pixels for the display. By pulsing its PB_4 output, the CPU controls a 74LS123 one-shot that generates a 300-nsec write-cycle pulse and gates the circuit's $\overline{DT}$ signal through to the video RAM's $\overline{DT}/\overline{OE}$ input.

The computer must also generate a 570-μsec vertical-sync signal after it counts 251 horizontal-retrace interrupts, one for each row of pixels on the display screen. The CPU increments by one its running count of horizontal-retrace interrupts as the interrupts occur. When the count reaches 251, the CPU pulses its PB_7 output, which in turn triggers a one-shot that generates a 570-μsec pulse. The external circuits synchronize the one-shot's output with the dot clock to generate the vertical-sync pulse, −VSYNC.

The video-control circuits also synchronize the video data bits from the 74LS195 shift register with the vertical- and horizontal-sync signals. The circuit's +HSYNC, −VSYNC, and VIDEO signals match the NTSC RS-170 specs closely **(Fig 4).** The circuit's video-control signals display reversed-video characters on an IBM PC monochrome monitor.

Interrupts drive the software

To operate the timing hardware and the video RAM, the controller relies on basic control routines and an interrupt-processing routine (**Listing 1,** pg 194). Upon power-up or after being reset, the program immediately disables the CPU from accepting external interrupts so it can perform initialization tasks without interruption. After the CPU completes its tasks, it enables the interrupts and then halts. This halt condition leaves the CPU in a known condition while it waits for a horizontal-retrace interrupt from timer 0.

Traditionally, after a microprocessor receives an interrupt signal, there's a chance of a delay: The μP has to complete an instruction before it can go to an interrupt-service routine. Because a microprocessor executes many types of instructions with varying instruction-cycle lengths, the interrupt delay depends on what the μP is doing when you interrupt it. As a result, in real-time applications where the μP is expected to generate precisely timed signals, you may forfeit timing consistency.

If the program holds the computer at a known instruction while it waits for interrupts, however, you avoid the interrupt-delay problem. In this CRT-control circuit, the μPD7811 halts after it enables the interrupts. The program returns to the halt state after it processes each interrupt's service request. As a result of starting all interrupt-processing tasks from a known place in the program, the software generates accurately timed signals. Even though the μPD7811 is in the halt mode, its on-chip peripherals continue to function normally.

The timer 0 interrupt occurs every 64 μsec (except during the vertical-retrace and character-processing times), forcing the computer into the HSYNC service

TEKTRONIX AIDED ENGINEERING

In the all-important race to market, speed is of the essence. The only way to stay ahead is with team engineering.

Developed by Tektronix as part of Tektronix Aided Engineering, team engineering speeds product development because it lets you partition even the biggest design. Teams of engineers can work in parallel, with concurrent access to the entire project.

Plus you can develop software and hardware in parallel, and concurrently test and verify your design.

At the heart of Tektronix team engineering is our powerful Designer's Database, which gives team members easy access to design information.

Each design entry instantly updates the database, providing engineers with the information they need to design it right the first time.

Plus you can share information and resources across multiple workstations throughout the network, making analysis and simulation results instantly available to everyone.

What's more, project managers can quickly and easily view the team's progress and check for compatibility and compliance with specifications, ensuring an integrated design.

All of which helps you shorten your design cycle and get to market faster, ahead of the competition.

It's all part of Tektronix Aided Engineering. A family of software design and test tools addressing each area of your product development cycle. From design capture and verification to placement and routing.

Best of all, it's backed by Tektronix. So you're assured of worldwide support and service to keep your systems up and running at peak performance.

To find out how Tektronix Aided Engineering can help your design team beat the clock, call 800/547-1512 (in Oregon, 800/542-1877). Or write: Tektronix, CAE Systems Division, 5302 Betsy Ross Drive, Santa Clara, CA 95052.

"Everybody working in parallel was the only way to handle it."
"We really beat the clock on this one."

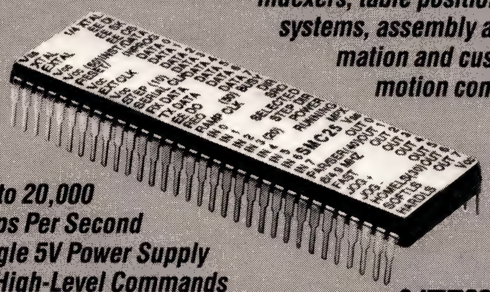
Tektronix®
COMMITTED TO EXCELLENCE

See us at DAC Booth #439

CIRCLE NO 106

Programmable STEP MOTOR CONTROLLER CHIP

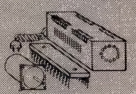
Ideal for robotics, machine controls, indexers, table positioning systems, assembly automation and custom motion control.



- Up to 20,000 Steps Per Second
- Single 5V Power Supply
- 32 High-Level Commands
- Stored Program Operations
- Absolute and Relative Position

$175.00 ea. 1-3 piece quantity

Anaheim Automation SMC25 is a high performance programmable step motor controller in a 64-pin compressed DIP package. The SMC25 will accept both relative and absolute move commands up to sixteen million steps. It can be programmed to automatically load and execute a program from an EEPROM at powerup, thus eliminating the need for a host computer in some applications.



ANAHEIM AUTOMATION
910 E. Orangefair Lane, Anaheim, CA 92801
(714) 992-6990
(86-1)

CIRCLE NO 108

Honeywell, Always A Step Ahead...

GALLIUM ARSENIDE IC FOUNDRY SERVICE . . . CALL HONEYWELL!

Our foundry is yielding LSI density products today, on time. Additionally, we can provide design assistance, packaging, and testing as required. Explore the reality...Honeywell delivers. Contact us today for complete information.

Honeywell
GaAs IC Product Center
830 East Arapaho Road
Richardson, TX 75081
800-328-5111 (ext. 1610)

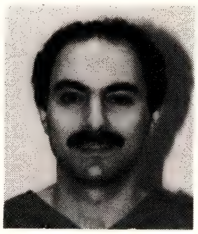
Together, we can find the answers.
Honeywell

CIRCLE NO 109

routine. The routine sends the row and column addresses to the video RAM for the next row of pixels, and it generates a horizontal-sync pulse.

Next, the CPU increments the row count and compares it with the value 251. If the values don't match, the CPU returns to the halt instruction. If a match occurs, the CPU generates a vertical-retrace signal. During the vertical-retrace time, the computer processes any new characters it receives from the USART or the keyboard. The character-checking operations take place during the vertical-retrace period because there are only 29 microseconds of unused CPU time between horizontal-sync pulses. The character-processing operations in the control software are very basic, so you may want to implement more extensive processing operations. **EDN**

Author's biography



David Davidian works as a software applications engineer at NEC Electronics Inc in Natick, MA. Employed by the company for five years, his duties include providing device-driver software and device-integration designs for the digital-signal-processing group. Dave has a BS degree in nuclear engineering from Lowell Technical Institute.

Article Interest Quotient (Circle One)
High 479 Medium 480 Low 481

TEKTRONIX AIDED ENGINEERING

Speeding your product to market demands faster PCB layout. The one sure way to do it is with MERLYN-P. The automated PCB layout system.

Developed by Tektronix as part of Tektronix Aided Engineering, MERLYN-P provides all the tools you need to zip through placement and routing.

Such as a placer that automatically places parts to minimize wire length between components. And interactive capabilities that let you easily swap components, pins and gates to reduce congestion and to perform "what if" analysis.

When it comes to routing, MERLYN-P automatically enforces user-defined design rules for automatic and interactive routing. You can also select from multiple strategies and specify design rules for each layer, ensuring fully routed, fully manufacturable boards.

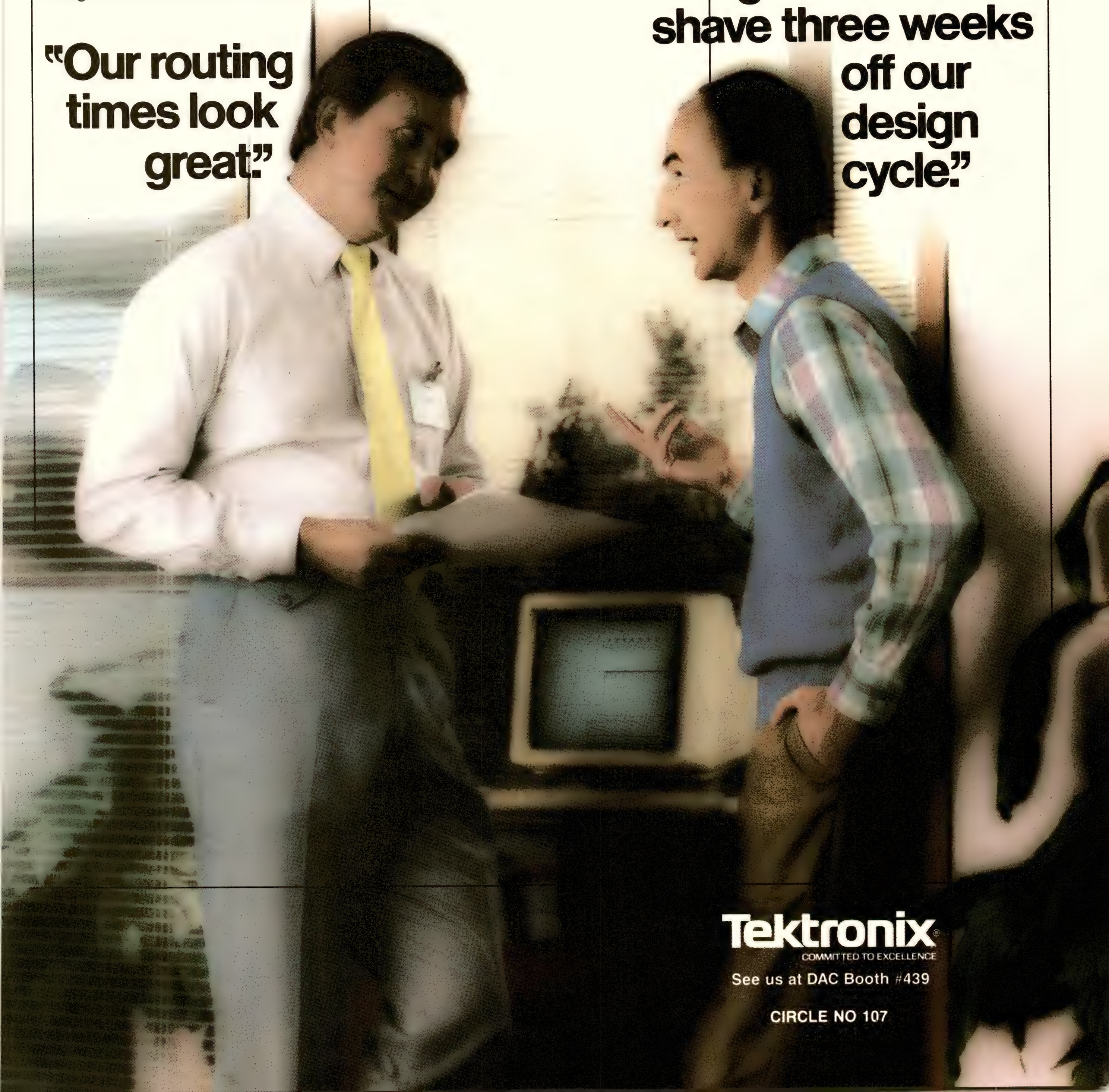
MERLYN-P also reduces the number of vias, removes hanging wires and eliminates staircases and sharp angles in the wire paths. Plus the system generates standard CAD/CAM artwork and output reports.

All of which helps you shorten your design cycle and get to market faster, ahead of the competition.

It's all part of Tektronix Aided Engineering. An integrated family of complete software solutions addressing each area of your product development cycle. From design capture and verification to placement and routing and computer-aided manufacturing.

Best of all, it's backed by Tektronix. So you're assured of worldwide support and service to keep your systems up and running at peak performance.

To find out how Tektronix Aided Engineering can help you shave weeks off your design cycle, call 800/547-1512 (in Oregon, 800/542-1877). Or write: Tektronix, CAE Systems Division, 5302 Betsy Ross Drive, Santa Clara, CA 95052.


"I figure we can shave three weeks off our design cycle."
"Our routing times look great."

Tektronix
COMMITTED TO EXCELLENCE
See us at DAC Booth #439

CIRCLE NO 107

LISTING 1

```
                        ;        CONTROL PROGRAM FOR 7811 BASED CRT TERMINAL

                        ;        SYSTEM EQUATES

             FFFF       STACK    EQU      0FFFFH  ;SET TOP OF STACK AT TOP OF MEMORY
             00FA       ROWMAX   EQU      250     ;MAX # OF DOT ROWS ON SCREEN
             0280       COLMAX   EQU      640     ;MAX # OF DOT COLUMNS ON SCREEN

                         ;        S T A R T   O F   P R O G R A M

             0000                 ORG      0       ;POWER ON RESET START ADDR LOC
0000 BA                           DI               ;TURN OFF INTERRUPTS
0001 D0                           JR       START   ;PROCEED TO START OF MAIN PROGRAM
0010                              ORG      10H     ;INTERRUPT INT1 VECTOR LOCATION
0010 4E44                         JRE      HSYNC   ;PROCESS HORIZ SYNC DURING HORIZ
                                                   ;BLANKING

                        START:
0012 6900                        MVI      A,0                ;INIT THE FOLLOWING VARIABLES
0014 707900FF                    MOV      ROW,A
0018 707901FF                    MOV      COL,A
001C 6909                        MVI      A,09H              ;SET SINGLE CHIP OPERATION
001E 4DD0                        MOV      MM,A               ;WITH PD=PF=OUT, INTERNAL RAM
                                                             ;ENABLE
0020 04FFFF                      LXI      SP,STACK           ;SETUP THE STACK POINTER
0023 69FF                        MVI      A,0FFH             ;SETUP PORT A
0025 4DD2                        MOV      MA,A               ;AS ALL INPUTS
0027 6900                        MVI      A,0                ;SETUP PORT B
0029 4DD3                        MOV      MB,A               ;AS ALL OUTPUTS
002B 6933                        MVI      A,33H              ;SET PORT C MODES PC0-TX
                                                             ;PC1-RX
002D 4DD1                        MOV      MCC,A              ;PC2,PC3,PC6,PC7-PORTS, PC4-TO,
                                                             ;PC5-CI
002F 69FF                        MVI      A,0FFH             ;SETUP PORT C AS INPUTS
0031 4DD4                        MOV      MC,A
0033 6900                        MVI      A,0                ;SETUP PORT F
0035 4DD7                        MOV      MF,A               ;AS ALL OUTPUTS
0037 64810D                      MVI      SMH,0DH            ;PHASE 384 CLK(@11.0592MHZ &
                                                             ;/16 = 1800 BAUD)
003A 69CE                        MVI      A,0CEH             ;X16 CLK, 8BIT CHAR, NO PARITY,
003C 4DCA                        MOV      SML,A              ;2 STOP BITS, TX AND RX ENABLE
003E 691D                        MVI      A,1DH              ;SETUP TIMER ZERO
0040 4DDA                        MOV      TM0,A              ;FOR A 64 MICROSEC
0042 648500                      MVI      TMM,0              ;SQUARE WAVE
0045 6407F7                      MVI      MKL,0F7H           ;KEEP ALL MASKABLE
0048 6406FF                      MVI      MKH,0FFH           ;INTR REQ MASKED BUT INT1
004B 40B400                      CALL     CLRVRAM            ;CLEAR THE VIDEO RAM
004E 11                          EXX                         ;SETUP ALT REG
004F 6E00                        MVI      H,0                ;H FOR COL DISPLAY COUNTER
0051 11                          EXX
0052 AA                          EI

                        ;                M A I N   P R O G R A M   L O O P
```

Listing continues on pg 196

Would you spend $200 to break up your logic and fault simulation bottleneck?

Here's an offer designed to knock your socks off. For only $200* (the cost of handling and mailing) you can try a *fully functional* evaluation version of SILOS® for 30 days. We've chosen this way to *prove* to you just how good SILOS is. Use it to design your next MOS/VLSI circuit and you'll *really* toss your socks. Because SILOS makes shorter work of one of the most frustrating, time consuming tasks in circuit design. *Even if you're up to your ankles in other logic simulation tools.*

UNPRECEDENTED PERFORMANCE
SILOS gives you amazingly fast and accurate modeling of both unidirectional and bidirectional networks. This field-proven package provides one of the fastest and most efficient ways to perform logic and concurrent fault simulation. With input and compile times that are five to ten times faster than anything else. It comes with advanced testability analysis. And, as an option, a TTL modeling library for systems design. Unlike other simulation tools SILOS adds only minimally to computer overhead. So you never have to trade response time for capability.

COMPREHENSIVE MODELING POWER
SILOS combines switch-level, gate-level, flip-flop and user-defined functional/behavioral simulations in a single package. Plus bidirectional signal propagation. And charge decay. Along with charge sharing. Not to mention spike effects. So you get all the industry standard modeling states. And a whole lot more.

HIGHEST ACCURACY
With its highly accurate 12-state simulation algorithm, SILOS gives you the ability to create flawless network models. And because the package is thoroughly tested and exceedingly clean, you get trouble free operation. Plus unusually reliable results.

USER CONSIDERATE TOO
Learning SILOS couldn't be easier. In fact, most users are up and running in only 20 minutes after receiving the program. After a quick perusal of the manual, you'll be a SILOS pro. And, whether you're running in batch or interactive mode, SILOS is a breeze to use. Data descriptions are natural. Logical. Intuitive. With deep macro nesting capabilities. So you save considerable time and trouble.

Results are compact and readable. They can be output in any number of tabular and graphic formats. Simulations are stored automatically. This makes it extremely easy to restart them and make modifications. Best of all, SILOS does things *your* way. Because—unlike many design tools—it was designed by *engineers* not programmers. So you can concentrate on your design—not on beating an ornery system.

AT HOME ALMOST ANYWHERE
SILOS works smoothly with the latest and best in CAD software tools. It runs on almost any workstation, mini or 32-bit mainframe you can name. Including IBM's. There's even a micro version—P-SILOS™—for the IBM PC/AT/XT™ and compatibles.

YES. KNOCK MY SOCKS OFF!
Send me information on SILOS and the special evaluation offer.

Name
Company
Address
City
Computer hardware used
Sock size: ☐ small ☐ medium ☐ large
Title
State/Zip
Phone ( )
EDN62686

Mail to SimuCad, P.O. Box 3400, 920 Incline Way, Building 2, Incline Village,
Nevada 89450. Telephone (702) 831-1399.

STEP ON IT!
To take advantage of this terrific offer, or to learn more about SILOS, see us at DAC, June 29th through July 2nd. For the first 100 responses *we'll even throw in a pair of socks.*

If you can't make the show, send in the coupon or call us on our TOLL-FREE number, 1-800 FASTSIM. In Nevada call (702) 831-1399.

*This offer is conditional upon respondents signing nondisclosure agreements. $200 30-day use fee is, of course, deductible from SILOS package price.

® 1985 SimuCad. P-SILOS is a registered trademark of SimuCad. IBM PC/AT and IBM PC/XT are registered trademarks of International Business Machines.

CIRCLE NO 110

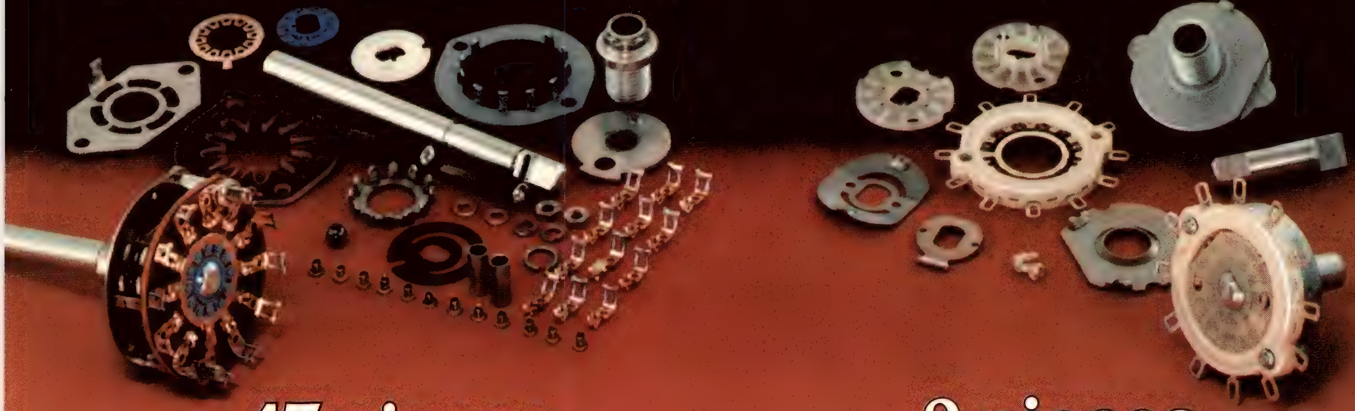
See SILOS by SimuCad® at DAC. (Booth #751)

LISTING 1 *(Continued)*

```
                    WAIT:
0053 483B                    HLT                           ;HALT AND WAIT FOR INTERRUPT
0055 FD                      JR       WAIT                 ;RET FROM INTR
                    ;
                    ;                     INT1
                    ;       HORIZONTAL-SYNC INTERRUPT ROUTINE
                    ;       GENERATED WHEN A TIMER HAS GENERATED
                    ;       A HORIZONTAL SYNC INTERVAL PULSE
                    ;
                    ; CHKS FOR ROWMAX HSYNC AT WHICH POINT A VSYNC
                    ; IS GENERATED. ALSO BEFORE RET A ROW OF DOTS
                    ; IS OUTPUT TO THE SCREEN (IE A DATA TRANSFER
                    ; CYCLE - PORT B ACTIVE).
                    ;
                    ;        PB4                 PB5              PB6              PB7
                    ;        WR/START            OE/DT/ CNTL      HSYNC/           VSYNC/

                    ;        PD        COL   ADDR
                    ;        PF        ROW   ADDR

                    HSYNC:
0056 11                      EXX                  ;USE ALTERNATE REG SET
0057 69DF                    MVI      A,0DFH      ;BEFORE ANYTHING SET OE/DT/
0059 4DC1                    MOV      PB,A        ;LOW
005B 6900                    MVI      A,0         ;SETUP A COLUMN
005D 4DC3                    MOV      PD,A        ;ADDR OF ZERO ALWAYS
005F 0E                      MOV      A,H         ;COPY CURRENT ROW
0060 4DC5                    MOV      PF,A        ;INTO ACC AND SET ROW ADDR
0062 698F                    MVI      A,8FH       ;SETUP TO INITIATE A WR VRAM PROCESS
                                                  ;AND AN HSYNC/
0064 4DC1                    MOV      PB,A        ;WITH WR/START=OE/DT=HSYNC/=LOW,
                                                  ;VSYNC=HI
0066 69FF                    MVI      A,0FFH      ;SET HSYNC/
0068 4DC1                    MOV      PB,A        ;AND ALL OTHERS HI
006A 744601                  ADI      H,1         ;ADVANCE THE DISPLAY ROW
006D 746EFA                  NEI      H,ROWMAX;CHK IF A VERTICAL SYNC
0070 407600                  CALL     VSYNC       ;IS REQUIRED
0073 11                      EXX                  ;RESTORE NORMAL
0074 AA                      EI                   ;REENABLE INTERRUPTS
0075 62                      RETI

                    ; VERTICAL SYNC MODULE. REINIT DISPLAY PARAMETERS, GENERATE A
                    ; VSYNC/, THEN CHK FOR A USART OR KEYBRD CHAR
                    ; AND PROCESS CHAR TO CRT DISPLAY.

0076 BA             VSYNC:   DI                            ;NO INTR DURING CHAR WR TO VRAM
0077 6900                    MVI      A,0                  ;SETUP TO
0079 707904FF                MOV      ROWCNT,A             ;RESET HSYNC ROW COUNTER
007D 697F                    MVI      A,7FH                ;SETUP TO SET VSYNC/ LOW
007F 4DC1                    MOV      PB,A                 ;W/ ALL OTHERS INACTIVE
0081 69FF                    MVI      A,0FFH               ;NOW SET VSYNC/ AND
0083 4DC1                    MOV      PB,A                 ;ALL OTHERS HI
0085 D2                      JR       KYBD                 ;CHK FOR ANY CHARS TO PROCESS
```

Listing continues on pg 198

Which switch would you pick for reliability?



47 pieces

Conventional rotary selector switch 1-pole, 11-position

9 pieces

CTS insert molded rotary selector switch 1-pole, 11-position

It is very apparent that the CTS rotary selector switch—*with only 19% as many separate parts* as an ordinary switch—offers greater stability and precision switching even under punishing use or severe shock and vibration. Insert molding locks every CTS terminal in place for positive, precise switching—even after thousands of operations.

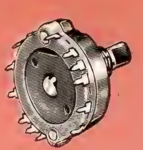
Take another look at this picture of reliable performance. Compare the many tiny, fragile pieces in an ordinary switch that can become mis-aligned and cause problems in the field. Remember the simple, solid construction of a CTS rotary. You can't make a mistake when you specify the switch that's *built to be most reliable.*

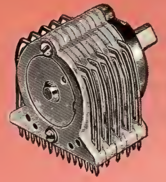
For a complete catalog of reliable CTS rotary selector switches—both stock and custom, call your CTS sales engineer or write: CTS Corporation, Elkhart Division, 1142 W. Beardsley Ave., Elkhart, IN 46514. Phone: (219) 295-3575. ***West of Mississippi River:*** CTS Corporation,* Paso Robles Division, 500 Linne Rd., Paso Robles, CA 93446. Phone: (805) 238-0350.

*In Calif. dba CTS Electronics Corporation.

CIRCLE NO 111

CTS offers thousands of PC board rotary switch variations—all with insert molded reliability

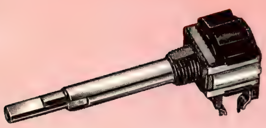




Select from a wide variety of shorting, non-shorting or mixed circuitry—as well as a range of index assemblies and wafer constructions for either perpendicular or parallel PCB mounting. Also available with AC power switches and variable resistors.

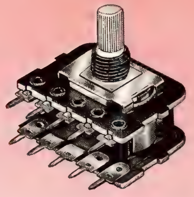
CTS® MEANS RELIABILITY

CTS CORPORATION • ELKHART, INDIANA



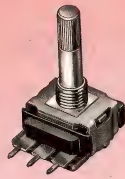
Series 288
Electronic Tuner Switch
Phone: (219) 295-3575

CIRCLE NO 112



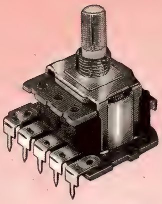
Series 288
Rotary Selector Switch
Phone: (219) 295-3575

CIRCLE NO 113



Series 288
Two-bit Shaft Encoder
Phone: (219) 295-3575

CIRCLE NO 114



Series 288
Spring Return Switch
Phone: (219) 295-3575

CIRCLE NO 115

LISTING 1 *(Continued)*

```
                     ; MAIN USART AND KEYBOARD SCAN ECHO AND CHAR PROCESSING MODULE

                     IOSCAN:
0086 4849                     SKIT     FSR              ;CHK FOR USART RX INT REQ
0088 CF                       JR       KYBD             ;IF NO USART CHAR THEN CHK KYBD
0089 4CD9                     MOV      A,RXB            ;READ CHAR FROM USART
008B 077F                     ANI      A,07FH           ;KEEP LOWER 7 BITS
008D 707905FF                 MOV      USCHAR,A         ;SAVE COPY OF USART CHAR
0091 40AE00                   CALL     XMIT             ;ECHO CHAR TO HOST
0094 40DF00                   CALL     PROCESS          ;PROCESS A CHARACTER
0097 B8                       RET

0098 4CC2            KYBD:    MOV      A,PC             ;CHK THE KEYBOARD STROBE LINE
009A 0780                     ANI      A,80H            ;MASK OUT ALL BITS BUT STROBE
                                                        ;BIT #PC7
009C 7780                     EQI      A,80H            ;CHK FOR ACTIVE-HI STROBE
009E B8                       RET                       ;IF NO KYBD CHAR THEN RET

009F 4CC0                     MOV      A,PA             ;GET COPY OF KYBD CHAR
00A1 077F                     ANI      A,7FH            ;STRIP OFF PARITY BIT
00A3 40AE00                   CALL     XMIT             ;ECHO CHAR TO HOST
00A6 707906FF                 MOV      KBCHAR,A         ;SAVE CHAR IN MEMORY
00AA 40DF00                   CALL     PROCESS          ;PROCESS A CHARACTER
00AD B8                       RET

00AE 484A            XMIT:    SKIT     FST              ;SKIP IF TX BUFFER EMPTY
00B0 FD                       JR       XMIT             ;LOOP TILL TX BUFFER EMPTY
00B1 4DD8                     MOV      TXB,A            ;SEND CHAR TO USART
00B3 B8                       RET

                     ; THIS ROUTINE CLEARS THE VRAM

                     CLRVRAM:
00B4 6F00                     MVI      L,0              ;SETUP ROW ADDR OF ZERO
00B6 6E00                     MVI      H,0              ;SETUP COL ADDR OF ZERO
                     CLRLOOP:
00B8 69F0                     MVI      A,0F0H           ;SETUP DATA NIBBLE OF ALL ZERO
00BA 40CC00                   CALL     WRITERAM         ;WRITE TO VRAM
00BD 744601                   ADI      H,1              ;INCREMENT THE COL ADDR TIL IT
00C0 747E00                   EQI      H,0              ;OVERFLOWS (FINISHED 256 COLS)
00C3 F4                       JR       CLRLOOP          ;LOOP TIL DONE
00C4 744701                   ADI      L,1              ;INCREMENT THE ROW ADDR TIL IT
00C7 747F00                   EQI      L,0              ;OVERFLOWS (FINISHED 256 COLS)
00CA ED                       JR       CLRLOOP          ;LOOP TIL DONE
00CB B8                       RET

                     ; WRITE A NIBBLE OF DATA IN A REG LOW NIBBLE
                     ; TO ROW ADDR IN L REG AND COL ADDR IN H REG
                     ; TO THE VRAM  (USING OE/ CNTLED WR CYCLE)

                     ; ENTER W/ UPPER NIBBLE OF REG A (DATA NIBBLE) SET TO F

                     WRITERAM:
```

Listing continues on pg 200

THE RASTERIZER ROADBLOCK

Users with old-fashioned multi-pass color electrostatic plotters have to wait up to two hours for an E-sized plot to be rasterized before the plotter begins plotting! Thanks to Benson, there's now a better way to obtain large-scale, full-color plots.

vs. THE BENSON BYPASS

Benson's single-pass color electrostatic plotter rasterizes "on the fly"—while the plotter plots! You'll be able to see your plots in minutes, not hours.

Benson's single-pass plotter eliminates problems associated with multi-pass plotters, like paper stretching. In Benson's plotter, the paper passes the heads only once; it doesn't go back and forth. Image registration is accomplished electronically, not mechanically. And the complex hydraulic systems needed to raise and lower toner baths in multi-pass plotters have been eliminated. Benson's proprietary writing/toning stations remain stationary as the paper passes by—in a single pass.

Benson's color electrostatic plotter, with its built-in raster engine, costs about the same as a multiple-pass plotter and a separate, "bit-mapping" controller.

This is simplicity itself—the best way to quickly generate large scale, full-color plots. Call your Benson representative for more details!*

- Built-in raster engine rasterizes as the plotter plots.
- Single-pass technology assures tighter registration.
- Generates an E-sized color plot in as little as 3.38 minutes.
- 254 dpi resolution, 256 pre-set colors and 256 user-selectable colors.

*See Computer Graphics World, March 1986: "Multi-Pass vs. One-Pass Plotters" for more information about this exciting new technology.

CIRCLE NO 116

benson

Plotters that Perform...

IN COLOR!

385 Ravendale Drive
P.O. Box 7169
Mt. View, CA 94039-7169
Telephone: 415-964-7900
Telex: 4941178 BENUW

IN EUROPE: Z. I. Petites Haies
1 rue Jean-Lemoine
94015 Creteil, France
Telephone: (1) 4898.92.05
Telex: 210 845

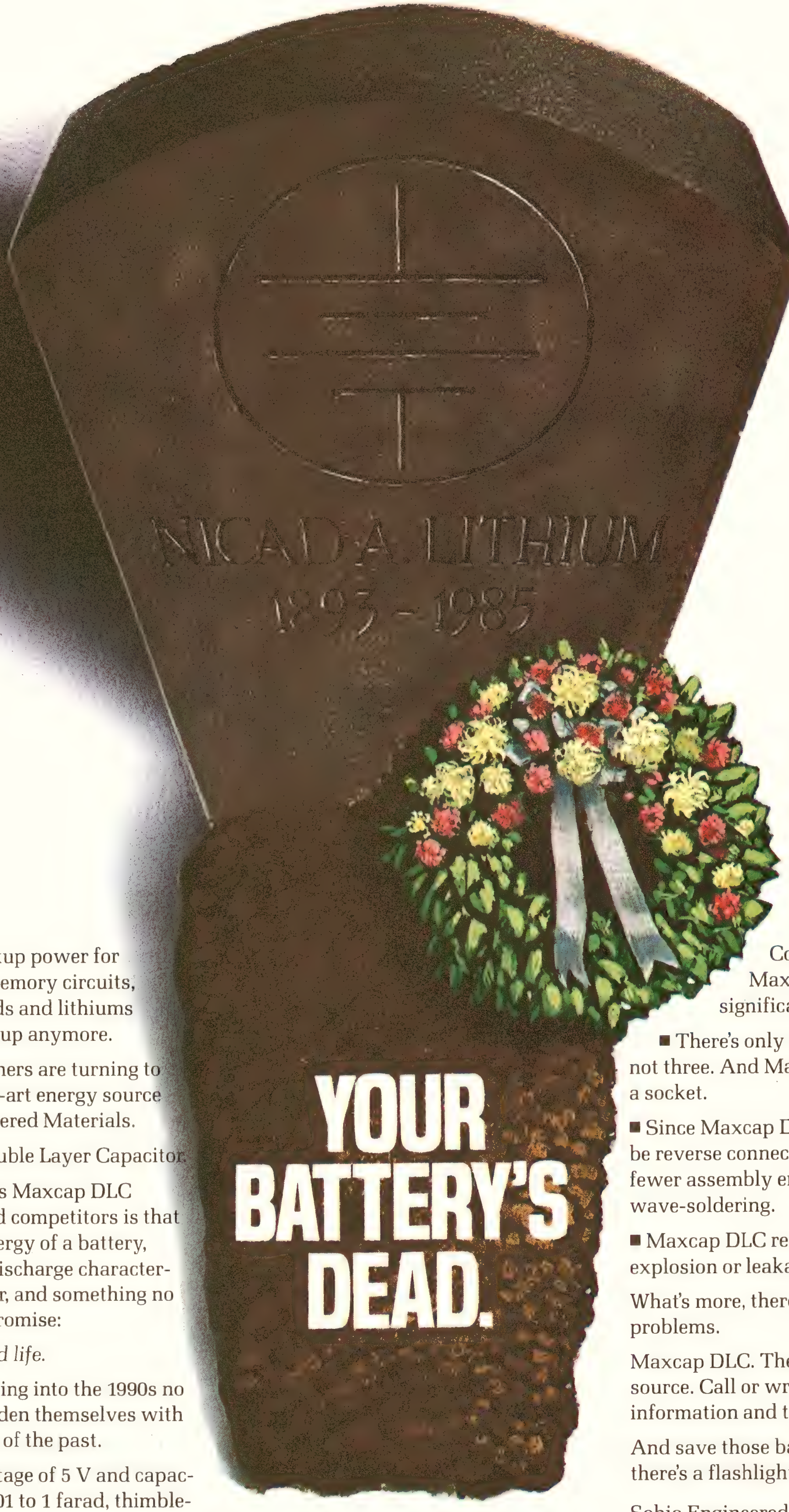
BENSON
Schlumberger

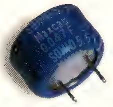
©1986 Benson, Inc.

LISTING 1 *(Continued)*

```
00CC 4DC1                MOV      PB,A           ;SETUP DATA NIBBLE AT DATA PORT
                                                 ;WITH CNTL LINES INACTIVE
00CE 0F                  MOV      A,L            ;SETUP THE ROW ADDR
00CF 4DC5                MOV      PF,A
00D1 0E                  MOV      A,H            ;SETUP THE COL ADDR
00D2 4DC3                MOV      PD,A
00D4 4CC1                MOV      A,PB           ;READ PORT B - KEEP DATA INTACT
00D6 07EF                ANI      A,0EFH         ;SETUP FOR AN OE/ CNTRLED WR
                                                 ;VRAM
00D8 4DC1                MOV      PB,A           ;WITH DATA NIBBLE KEPT AT ZERO
00DA 69F0                MVI      A,0F0H         ;THEN INACTIVATE THE CNTL LINES
00DC 4DC1                MOV      PB,A           ;WITH DATA NIBBLE KEPT AT ZERO
00DE B8                  RET

                ; PROCESS A CHARACTER: USE THE CHARACTER FROM KEYBOARD
                ; OR USART AS INDEX INTO CHAR LOOKUP ROM
                ; SEND CHARACTERS BIT PATTERN TO THE VRAM.
                ; UPDATE ROW AND COL AND CHECK SCROLL COND

                PROCESS:
00DF B0                  PUSH     V              ;SAVE COPY OF INPUT CHAR
00E0 706900FF            MOV      A,ROW          ;CHK IF THE CHAR ROW TO DISPLAY
00E4 67FA                NEI      A,ROWMAX       ;IS AT THE END OF THE MAX ROW
00E6 406401              CALL     SCROLL         ;IF ROW=25, SCROLL THE DISPLAY
00E9 706901FF            MOV      A,COL          ;CHK IF ROW MUST POINT TO NEXT
                                                 ;CHAR (NIBBLE)
00ED 77A0                EQI      A,COLMAX/4     ;BY CHKING IF WE ARE AT THE
                                                 ;LAST CHAR COL
00EF D0                  JR       SAMELN         ;IF NOT LAST COL THEN PROCEED
00F0 6900                MVI      A,0            ;IF AT LAST COL THEN
00F2 707901FF            MOV      COL,A          ;REINIT COL TO ZERO
00F6 706900FF            MOV      A,ROW          ;SETUP TO POINT THE ROW LOC
00FA 460A                ADI      A,10           ;TO THE NEXT 10 PIXELS DOWN
00FC 707900FF            MOV      ROW,A          ;STARTING THE NEXT CHAR LINE
0100 A0         SAMELN:  POP      V              ;RESTORE ASCII CHAR INPUT
0101 6A08                MVI      B,8            ;SETUP TO MULTIPLY ASCII CHAR
0103 482E                MUL      B              ;BY 8 AS INDEX INTO CHAR ROM
                                                 ;ANS IN EA
0105 347901              LXI      H,CHAROM       ;POINT HL TO CHAR ROM ADDR
0108 6A08                MVI      B,8            ;SETUP 8 ROW SCAN COUNTER IN B
010A B1         SCANCHR:PUSH      B              ;SAVE LOOP COUNTER VALUE
010B AE                  LDAX     H+EA           ;GET CHAR BIT PATTERN FROM ROM
010C B3                  PUSH     H              ;SAVE CHAR ROM START ADDR
010D 1B                  MOV      C,A            ;SAVE CURRENT BIT PATTERN BYTE
010E 4831                RLR      A              ;COPY THE UPPER NIBBLE
0110 4831                RLR      A              ;INTO THE LOWER NIBBLE, WHICH
0112 4831                RLR      A              ;WILL BE SENT FIRST
0114 4831                RLR      A
0116 17F0                ORI      A,0F0H         ;SET UPPER NIBBLE TO ALL 1'S
0118 706F00FF            MOV      L,ROW          ;GET CURRENT ROW ADDR INTO L
011C 706E01FF            MOV      H,COL          ;GET CURRENT CAL ADDR INTO H
0120 40CC00              CALL     WRITERAM       ;WRITE LOWER NIBBLE INTO VRAM
```

Listing continues on pg 202





As backup power for CMOS memory circuits, the ni-cads and lithiums just don't measure up anymore.

Now, circuit designers are turning to a new, state-of-the-art energy source from Sohio Engineered Materials.

The Maxcap™ Double Layer Capacitor.

What distinguishes Maxcap DLC from its antiquated competitors is that it gives you the energy of a battery, the rapid charge-discharge characteristics of a capacitor, and something no battery can ever promise:

Virtually unlimited life.

So designers working into the 1990s no longer have to burden themselves with power sources out of the past.

At its nominal voltage of 5 V and capacitance values of 0.01 to 1 farad, thimble-size Maxcap DLC can be charged and discharged indefinitely without maintenance or replacement. Since there's no need for access, equipment can be made smaller and simplified. You can also reduce backup circuit and assembly costs.

Compared to batteries, Maxcap DLC delivers these significant cost savings:

- There's only one extra component, not three. And Maxcap DLC doesn't need a socket.
- Since Maxcap DLC is nonpolar, it can't be reverse connected, so you'll have fewer assembly errors. And you can use wave-soldering.
- Maxcap DLC requires no toxicity, explosion or leakage safeguards.

What's more, there are no disposal problems.

Maxcap DLC. The timeless energy source. Call or write for complete information and technical details.

And save those batteries. Somewhere, there's a flashlight that can use them.

Sohio Engineered Materials Company
Semiconductor Products Division
P.O. Box 664
Niagara Falls, NY 14302
716/278-3954

SOHIO

**Sohio
Engineered Materials
Company**

Maxcap DLC shown actual size above.

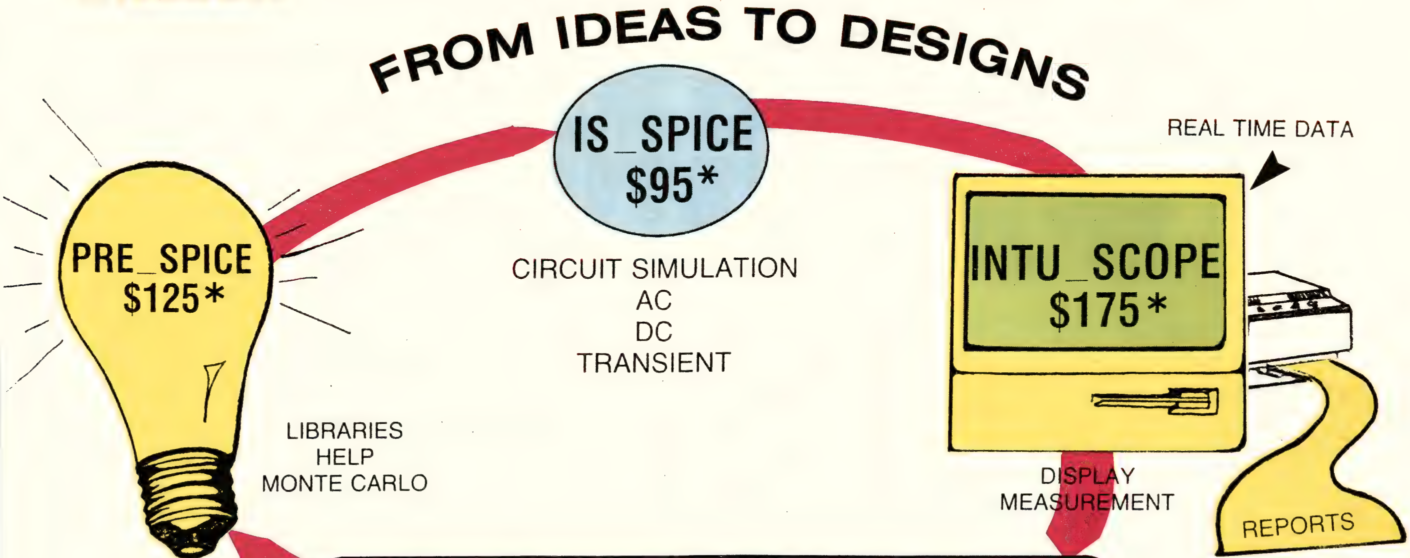
CIRCLE NO 117

LISTING 1 *(Continued)*

```
0123 706901FF             MOV    A,COL            ;GET THE CURRENT COL ADDRESS
0127 41                   INR    A                ;ADVANCE IT BY ONE
0128 707901FF             MOV    COL,A            ;RESTORE UPDATED COL IN STORAGE
012C 1E                   MOV    H,A              ;COPY IT INTO REG H
012D 706F00FF             MOV    L,ROW            ;GET CURRENT ROW ADDR INTO L
0131 0B                   MOV    A,C              ;COPY CHAR FROM ROM
0132 17F0                 ORI    A,0F0H           ;SET UPPER NIBBLE TO ALL 1'S
0134 40CC00               CALL   WRITERAM         ;WRITE UPPER NIBBLE INTO VRAM
0137 706901FF             MOV    A,COL            ;SETUP TO RESTORE THE ORIGINAL
013B 51                   DCR    A                ;COLUMN ADDR
013C 707901FF             MOV    COL,A            ;BEFORE NEXT 2 NIBBLES GET
                                                  ;DISPLAYED
0140 A3                   POP    H                ;RESTORE CHAR ROM START ADDR
0141 32                   INX    H                ;POINT TO NEXT CHAR ROW BYTE IN
                                                  ;CHAR ROM
0142 706900FF             MOV    A,ROW            ;SETUP TO POINT THE ROW
0146 41                   INR    A                ;POINTER TO POINT
0147 707900FF             MOV    ROW,A            ;TO NEXT DISPLAY ROW
014B A1                   POP    B                ;RESTORE LOOP COUNTER VALUE
014C 52                   DCR    B                ;DECREMENT SCAN LOOP COUNTER
014D 4FBB                 JRE    SCANCHR          ;LOOP TILL DONE
014F 706901FF             MOV    A,COL            ;SETUP TO POINT THE COL LOC
0153 4602                 ADI    A,2              ;REQUIRED FOR THE NEXT CHAR
0155 707901FF             MOV    COL,A            ;CHAR LOC ON SCREEN
0159 706900FF             MOV    A,ROW            ;SETUP TO POINT ROW TO NEXT
015D 7609                 SBI    A,9              ;CHAR LOCATION TO
015F 707900FF             MOV    ROW,A            ;RIGHT
0163 B8                   RET

0164 706900FF    SCROLL:  MOV    A,ROW            ;ADJUST THE CHAR ROW POSITION
0168 760A                 SBI    A,10             ;UP BY ONE CHAR POSN FOR A
016A 707900FF             MOV    ROW,A            ;SINGLE ROW SCROLL
016E 706902FF             MOV    A,ROWDISP        ;START THE DISPLAY ROW DOWN
0172 460A                 ADI    A,10             ;BY 1 CHAR POSITION
0174 707902FF             MOV    ROWDISP,A
0178 B8                   RET

                 ;        PROGRAM VARIABLE STORAGE AREA

          FF00   ORG      0FF00H                  ;START VARIABLE LOCS AT 7811
                                                  ;RAM START ADDR
FF00 00          ROW:            DB     0         ;ROW OF CURRENT DISPLAY CHAR
FF01 00          COL:            DB     0         ;COL OF CURRENT DISPLAY CHAR
FF02 00          ROWDISP:        DB     0         ;ROW OF CURRENT HSYNC DOT LINE
FF03 00          COLDISP:        DB     0         ;COL OF CURRENT HSYNC DOT LINE
FF04 00          ROWCNT:         DB     0         ;IF=251 THEN PERFORM A VSYNC
FF05 00          USCHAR:         DB     0         ;USART CHARACTER STORAGE
FF06 00          KBCHAR:         DB     0         ;KEYBOARD CHARACTER STORAGE
                 END
```

intusoft

Personal Computer Circuit Design Tools

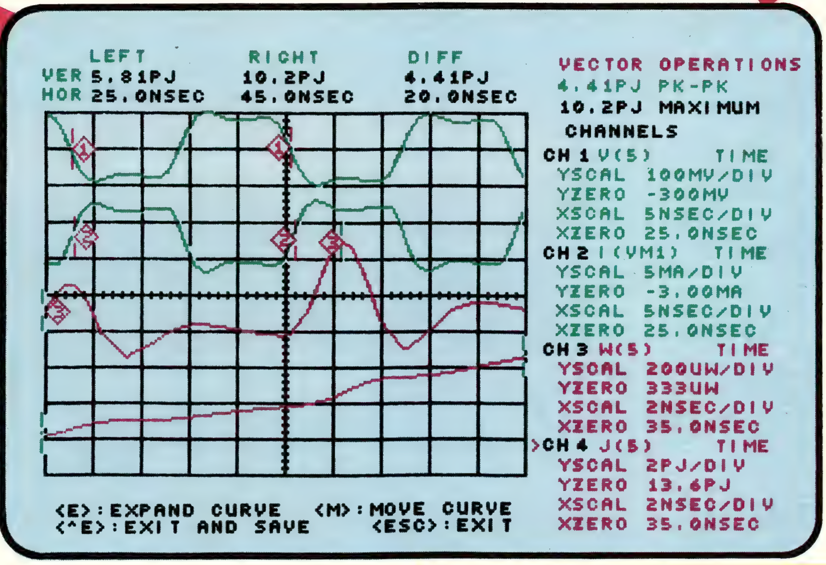


Cursor Read Out, A continuous update of both cursors

Cursor Tags identify waveforms and mark them for print out

Plot Colors are selectable

Help Menu viewed using space bar



```
      LEFT           RIGHT         DIFF          VECTOR OPERATIONS
VER 5.81PJ        10.2PJ        4.41PJ           4.41PJ PK-PK
HOR 25.0NSEC      45.0NSEC      20.0NSEC         10.2PJ MAXIMUM
                                                  CHANNELS
                                                 CH 1 V(5)       TIME
                                                  YSCAL  100MV/DIV
                                                  YZERO  -300MV
                                                  XSCAL  5NSEC/DIV
                                                  XZERO  25.0NSEC
                                                 CH 2 I(VM1)     TIME
                                                  YSCAL  5MA/DIV
                                                  YZERO  -3.00MA
                                                  XSCAL  5NSEC/DIV
                                                  XZERO  25.0NSEC
                                                 CH 3 W(5)       TIME
                                                  YSOAL  200UW/DIV
                                                  YZERO  333UW
                                                  XSCAL  2NSEC/DIV
                                                  XZERO  35.0NSEC
                                                >CH 4 J(5)       TIME
                                                  YSCAL  2PJ/DIV
                                                  YZERO  13.6PJ
 <E>:EXPAND CURVE   <M>:MOVE CURVE                XSCAL  2NSEC/DIV
 <^E>:EXIT AND SAVE      <ESC>:EXIT               XZERO  35.0NSEC
```

Reverse Polish stack and accumulator display measured values

X-Y axis selected from analysis data

Oscilloscope Scale values in a 1, 2, 5 sequence

Units automatically calculated

A circuit designer's dream! Over 1 million bytes of code turns a Personal Computer into a Circuit Design Laboratory. Mathematical models are explained and included in libraries so you can begin simulations immediately. The powerful SPICE program developed at U.C. Berkeley is adapted to run on your PC as *IS_SPICE*. A software oscilloscope, *Intu_Scope*, reduces and displays data and can be programmed for automatic data acquisition and reduction. All programs run on IBM PC's including the XT and AT and on many compatibles. DOS 2.x or 3.x is required. Documentation is provided in a 7 by 9 in. 3 ring binder. For all three programs it comes to over 200 pages with 6 diskettes formatted to 360K bytes.

PRE_SPICE: Used to prepare a circuit description and to control an iterative Monte Carlo Analysis. Featuring an extended *IS_SPICE* syntax, compatible with mainframe SPICE or other versions for the PC that conform to the Berkeley syntax, you can now include libraries by reference, pass parameters to subcircuits and identify parameter tolerances. Applications, a circuit library and tutorials on using *IS_SPICE* are included. Requires 256K RAM.

IS_SPICE: An adaptation of U.C. Berkeley SPICE vers. 2G.6 for use on PC's. Circuits of over 200 nodes have been run. IS_SPICE includes device non-linearities and built-in models for various semiconductor devices, passive devices, sources, controlled sources and signal generators. DC and Transient analysis include non-linearities while the AC analysis computes small signal transfer functions about the large signal operating point. Requires 640K RAM, fixed disk and coprocessor.

Intu_Scope: A general purpose program for waveform acquisition and manipulation. It performs complex waveform manipulations including Integration, Differentiation, Fourier Transform and combines waveforms through addition, subtraction, multiplication and division. Automated measurements are used with *PRE_SPICE* to extract and reduce Monte Carlo Analysis data. Supports dot matrix printer output that can also be included in word-processor output. Requires 256K RAM and color graphics.

IBM is the registered trademark of International Business Machines, Inc.
**Shipping is included. California residents add 6-1/2% sales tax.*

intusoft
P.O. Box 6607
San Pedro, CA 90734-6607

for information
call (213) 833-0710

CIRCLE NO 118

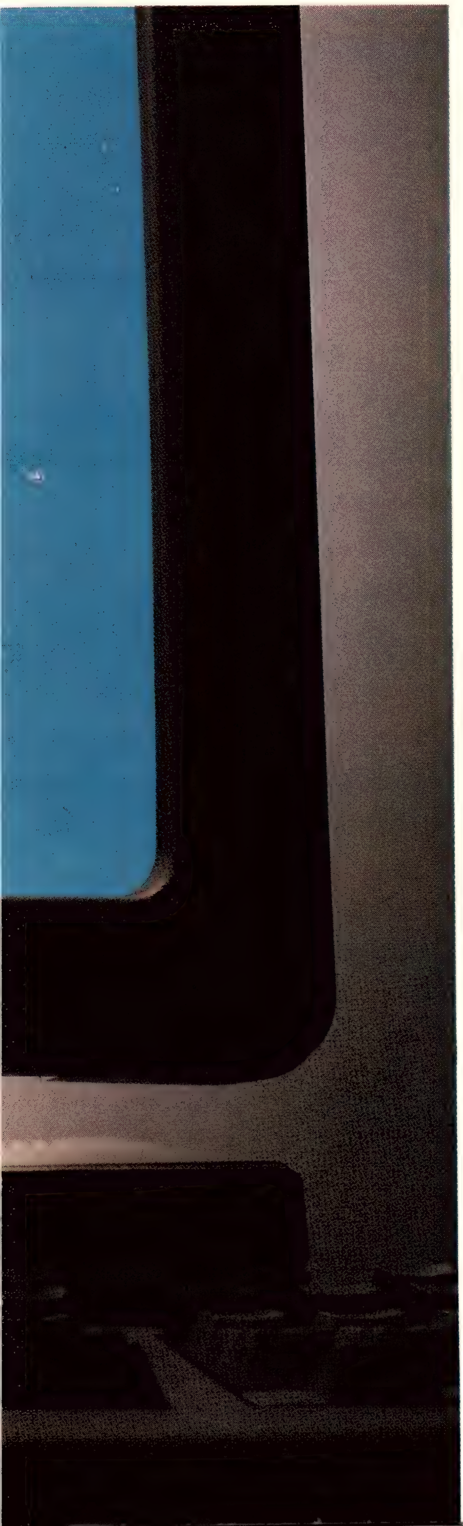
HOW FAST CAN THE 80386 MAKE YOUR WORKSTATION GO?

Faster than any other 32-bit microprocessor can.

In technical terms that's 4 MIPS. 4 MegaWhetstones. With 4 Gigabytes.

Fast enough to have a sudden and lethal impact on your competition.

To achieve its blazing speed, the 80386 has six-stage pipelining, which allows the standard 16 MHz part to deliver over 6100 Dhrystones per second.



That's nearly four times the Dhrystone performance of a VAX* 11/780, or 4 VAX MIPS.

And with the 80386 you don't sacrifice all that performance for demand-paged virtual memory. Because of its on-chip paging unit and transparent paging cache, the 80386 can do a full virtual to physical address translation without the performance penalty of non-pipelined, off-chip designs. Giving you 4 MIPS of deliverable UNIX** performance.

Of course, to achieve performance like that, you need a bus that's faster than a speeding bullet.

Like our 2 clock bus that provides a 32 Megabytes per second transfer rate.

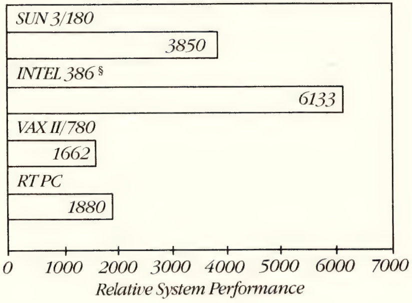
That's the highest performance of any microprocessor bus.

So what more could advanced system designers ask for?

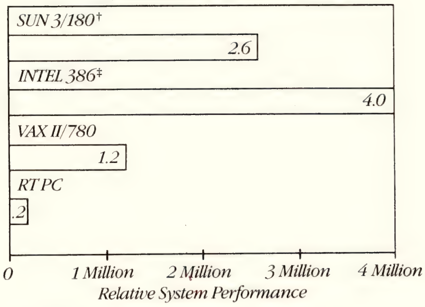
Blistering 4 MegaWhetstones per second performance for superb graphics and number crunching. Only the 80386 uniquely teams with Weitek's 1167 floating point coprocessor to deliver the highest numerics performance on the market.

And of course all this comes in a 64 Terabyte virtual address space with a 4 Gigabyte linear address space.

Dhrystones Per Second



Whetstones Per Second



§ Intel 386 MULTIBUS I 16MHz Starter Kit.*
† With Weitek 1164, 1165 floating point chip set.
‡ With Weitek 1167 floating point coprocessor.
Source: Refer to Intel 80386 Benchmark Report.

Finally, for your silver bullet, add to all this $6 billion worth of DOS software. And watch how fast it runs on your 4 MIPS, 4 MegaWhetstones UNIX machine.

To find out more, attend one of our 80386 Seminars. Call your local Intel sales office for details.

Or call (800) 548-4725 for complete technical information.

Get all the ammunition you need to make your next system a success.

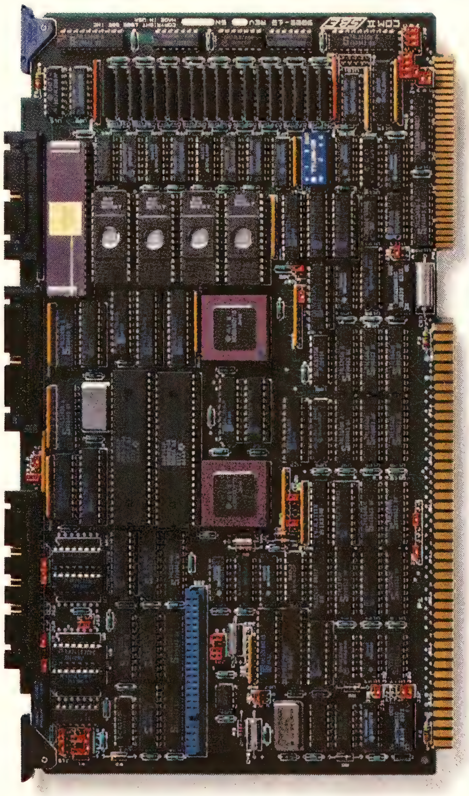
intel®

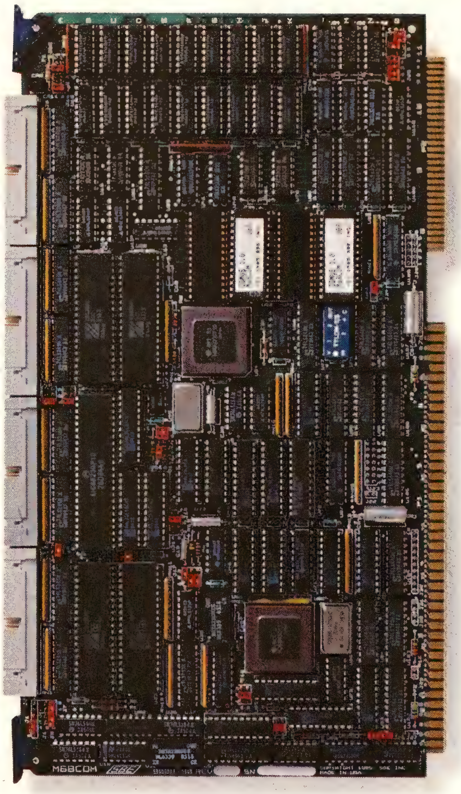
---

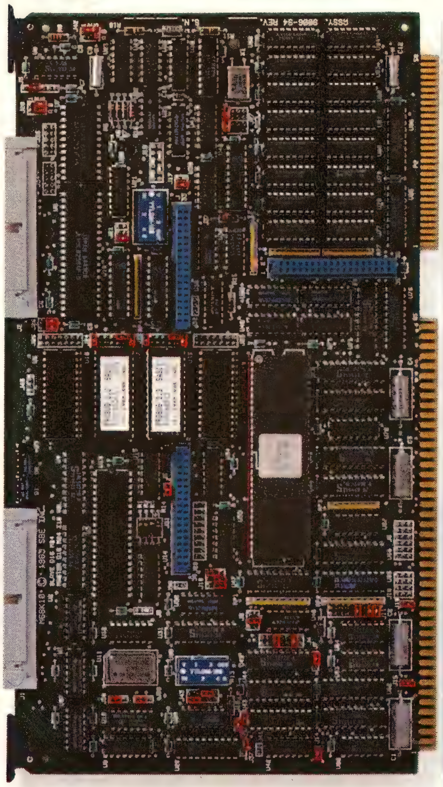
*VAX is a registered trademark of Digital Equipment Corp.
**UNIX is a trademark of AT&T Bell Laboratories.

© 1986 Intel Corporation

CIRCLE NO 119


COM-2


COM-8


M68K10

New X.25 solutions. From $1200.*

Three intelligent Multibus† boards from SBE, all with X.25 on board. Each is a complete X.25 communication solution. Each offers multiple hardware options. And all three are ready to use right out of the box.

There's no extra software to buy. You get everything you need to implement levels 1, 2 and 3 of the ISO model in your Multibus system.

Your choice of three communication boards gives you unprecedented hardware flexibility. Choose up to 8 serial ports. Baud rates from 1 bit to 3 megabits per second. DMA channels–2, 4, or none. And on-board RAM–128K, 256K, 512K, or 1 Megabyte.

The starting price is $1200 in quantity 100 for a card with two serial ports, 128K bytes of RAM, and X.25 in EPROM.

SBE offers in-depth technical suppor hard to find elsewhere. A phone call puts you right on the line with one of our top technical people.

We provide hardware, software and support–everything you need from a single source.

SBE, Inc., 2400 Bisso Lane, Concord, California 94520. Phone us for literature mailed the same day.

1-800-221-6458. In California 1-800-328-9900 or (415) 680-7722. TWX 910-366-2116.

SBE

Your partner in computer boards and systems.

---

*In quantity 100. Consult factory for other quantity prices.
†Multibus is a trademark of Intel.

CIRCLE NO 120

C compilers speed single-chip-µP development

Although it was once thought impossible, you can now write programs in C for single-chip microprocessors, such as the Intel 8051, Hitachi 6301, or Motorola 6801. You can therefore write and debug substantial parts of an application on a host computer. Should you have to change µPs, you can easily recompile your C code.

Corey Satten, *John Fluke Manufacturing Co Inc*

Because of recent advances in both C compilers and single-chip µPs, you can now use C to program single-chip µPs. You can program a given algorithm faster, more easily, and at less expense in C than in assembly language because the number of lines of C code needed to express the algorithm is fewer than the number of lines required by the assembly language.

Several aspects of C render programs easier to understand and modify at a later date than assembly-language code. First, C statements are shorter and easier to read than equivalent assembly-language constructs. This brevity enables you to achieve more functionality per page of C than is possible with assembly-language programs. Second, C provides data structures and flow-control constructs.

Third, C code is easier to validate because many C-programming tools are available to help you find errors in your programs. For example, code-coverage analyzers can tell you which lines of your program were executed during testing. Utilities (for example, lint) check to ensure that your program uses variables consistently. Last, readily available run-time profilers and symbolic debuggers allow you to gain insight into your native-compiled program's execution as it runs in the controlled environment of a host before you download your cross-compiled program to the target system.

Another major advantage of using C is that you can often develop your software before, or simultaneously with, your hardware. Furthermore, while you're running your code in a software-simulation environment under an operating system like Unix, you'll be certain about whether a bug is in hardware or in software. Another benefit is that your software won't be tied to a particular µP. If your initial processor choice proves to be insufficient, you have the option of recompiling your program for a different µP.

Investments pay off

One more advantage of using C is that your investment in a C education and in a C programming environment will probably be of more lasting value than an investment in a particular assembly language. C has been around since the first µPs appeared, and it will still be around when next year's µPs arrive. A C subroutine library that you develop or use in house will retain its usefulness. Think about how much use you still have for, say, the Intel 8008 assembly language.

Using C for programming single-chip µPs does pres-

Text continued on pg 216

Compilers adapt to single-chip-µP world

```
                           ; register unsigned char a,b;
                           ; {
                                   global  _main
t0000                      _main
t0000 A8 81                        mov     r0,sp
t0002 E8                           mov     a,r0
t0003 24 08                        add     a,#`f1
t0005 F5 81                        mov     sp,a
t0007 74 3C                        mov     a,#`m1
t0009 12 e0000                     lcall   enter
t000C 74 F5                        mov     a,#-3-0-`f1
t000E 25 81                        add     a,sp
t0010 F8                           mov     r0,a
t0011 86 04                        mov     d4,@r0
t0013 74 F3                        mov     a,#-5-0-`f1
t0015 25 81                        add     a,sp
t0017 F8                           mov     r0,a
t0018 86 06                        mov     d6,@r0
                           ; register unsigned char c;
                           ; register unsigned int d;
                           ; a = b;
t001A 8E 04                        mov     d4,r6
                           ; a = c;
t001C 85 08 04                     mov     d4,r8
                           ; d = a;
t001F 8C 0C                        mov     d12,r4
t0021 75 0D 00                     mov     r13,#0
                           ; a += (b&c)+1;
t0024 EE                           mov     a,r6
t0025 55 08                        anl     a,r8
t0027 FA                           mov     r2,a
t0028 74 01                        mov     a,#1
t002A 2A                           add     a,r2
t002B FA                           mov     r2,a
t002C 2C                           add     a,r4
t002D FC                           mov     r4,a
                           ; d &= 255;
```

The heart of the compiler in the single-chip-µP software package that produced the main text's key-finder program is a partial retargeting of the Motorola 68000 Software Generation System (SGS) from AT&T. AT&T built the SGS from a portable C compiler, PCC2 (see **Ref 1**). The compiler described here is available from Seattle-based Specialized Systems Consultants Inc (phone (206) 367-8649).

The compiler's author did a partial retargeting of PCC2 because some features of the C language are not essential to, or do not make sense for, single-chip µPs. Briefly, the compiler does not handle the following (the associated C names are in quotation marks):

- Floating-point numbers (C names "float" and "double")
- 32-bit integers ("long")
- Bit fields (C bit-field operators are not portable, so most C programmers use Boolean operators instead)
- The passing and returning of structures by value (the compiler passes and returns only addresses of structures).

The compiler implements all of the rest of Unix C, including

- Structures and unions
- Enumerated and void types
- Signed and unsigned characters and integers ("char" and "int")
- Static, auto, and register storage classes
- All the C operators.

Most compilers first generate an assembly-language file and then automatically invoke an assembler. The single-chip-µP software packages described here lengthen this chain to allow a stream editor to perform processing on the assembly language before it's assembled into machine language. The stream editor makes changes in a text file similar to those a screen editor makes, but it gets its commands from a preprogrammed command file rather than from a keyboard.

Optional postprocessing

The stream editor performs two optional postprocessing functions. For the 6301 compiler, it can transform the 6301 code into code compatible with the Motorola 6801. The stream editor is also the major building block for a local, or "peephole," optimizer. The optimizer speeds a program by 10% and processes an assembler file at 10,000 lines per minute (on a 68010-based host).

A Unix-style cc driver ties the package's elements together. This facility allows the command lines that invoke native and cross compilation to be analogous to each other.

Utilities aid operation

Because software engineers commonly break C programs into files that are to be compiled and assembled separately, the location-counter field of each assembly listing begins, of necessi-

```
38  t002E 75 0D 00                     mov     r13,#0
39                                ; a = d>>8;
40  t0031 85 0D 02                      mov     d2,r13
41  t0034 7B 00                         mov     r3,#0
42  t0036 8A 04                         mov     d4,r2
43                                ; for (a=7; a&&b; a--)
44  t0038 7C 07                         mov     r4,#7
45  t003A                         `115
46  t003A EC                            mov     a,r4
47  t003B 70 03                         jnz     !+5
48  t003D 02 t005D                      ljmp    `114
49  t0040 EE                            mov     a,r6
50  t0041 70 03                         jnz     !+5
51  t0043 02 t005D                      ljmp    `114
52                                ; put8X(d,3);
53  t0046 7A 03                         mov     r2,#3<8
54  t0048 C0 02                         push    d2
55  t004A C0 10                         push    ZERO
56  t004C C0 0C                         push    d12
57  t004E C0 0D                         push    d13
58  t0050 12 e0000                      lcall   _put8X
59  t0053 E5 81                         mov     a,sp
60  t0055 24 FC                         add     a,#-4
61  t0057 F5 81                         mov     sp,a
62  t0059                         `113
63  t0059 1C                            dec     r4
64  t005A 02 t003A                      ljmp    `115
65  t005D                         `114
66                                ; }
67  t005D                         `112
68  t005D 78 00                         mov     r0,#`s1
69  t005F 74 3C                         mov     a,#`m1
70  t0061 02 e0000                      ljmp    exit
71        0000                    `t1   equ     0
72        0000                    `s1   equ     0
73        0008                    `f1   equ     8
74        003C                    `m1   equ     0x003c
```

Fig A—The 8051 cross compiler produced this listing *for some simple, but representative, statements. Lines 5 through 10 set up the stack frame. Notice that variables a, b, c, and d are in registers—not external RAM (lines 11 to 14, 15 to 18, 21 to 22, and 37 to 38). The program performs computations in line rather than with subroutines or library calls, thus reducing overhead. Although the C loop statement in line 43 has three parts, it compiles into a small number of statements.*

ty, at zero for each file. The software includes a utility that runs after linking and automatically adjusts the location-counter field of the assembly listings so they look like absolute assembly listings.

Fig A shows a sample program containing numerous examples of C code that have been compiled efficiently for the 8051. Note that the standard prelude sets up symbolic names d0 through d14 to refer to the same storage locations as r0 through r14. *(Ed Note: C programmers typically use lower-case letters where other programmers would use upper case, eg, r0 through r14 instead of R0 through R14.)* The program needs this equivalence because, unlike virtually every other µP, the 8051's push, pop, and move-indirect instructions must use direct addresses instead of the registers to which they are equivalent.

Also note that r8 through r14 are not physical registers but convenient notations for the appropriate parts of some pseudoregisters. Pseudoregisters are areas of the 8051's internal RAM that behave identically to real registers, but whose access instructions are each one byte longer than the instructions that access real registers.

To help the programmer during debugging, the compiler generates an assembly-language listing; the corresponding C code is interspersed as comments (see **Fig A**).

This single-chip C compiler is currently available on the VAX 4.2 BSD Unix operating system and on Sun workstations, the AT&T 3B2, the AT&T Unix PC 32000 (3B1), and the IBM PC/AT (System V Xenix). It costs $3500 ($1050 for subsequent copies).

You can encode a given algorithm faster, more easily, and at less expense in C than in assembly language.

ent some problems, however. The most common obstacle is the product pool itself. A C compiler may not be available for your target µP, or an available compiler may not run on your host computer (see **box,** "Compilers adapt to single-chip-µP world").

The next most common objection to using C is that compiled programs will require somewhat more ROM than handwritten equivalents. In addition, C programs may require slightly more RAM—or at least more effort on your part to conserve RAM. The increase in RAM usage comes about primarily because the compiler allocates function arguments and register variables at integer width. (Many, but not all, C compilers allocate integers as a 16-bit word; 8-bit words and instructions are more common for single-chip µPs.)

Because of these compiler- or language-induced drawbacks, areas of your program may require careful coding. You may even need to learn how to mix C with assembly language—for example, to optimize your software by recoding slow or frequently called routines. Another disincentive to using C is that the language consumes more host-computer time than assemblers do; instead of just reassembling your program at each edit/debug cycle, you must do a more lengthy recompilation.

Furthermore, although not having to write your program at the assembly-language level is a blessing, you must usually debug it at the assembly-language level on the target system. Descending from the limitless, timeless world of a host computer's virtual system to the sharply limited realm of a single-chip µP imposes an unfamiliar set of constraints upon a high-level language programmer.

Debugging a compiled C program at the assembly-language level can be more tedious than debugging a handwritten assembly program for two reasons. First, by writing in C, you weren't forced to become intimately familiar with the target processor's instruction set;

```
#define MARGIN 50        /* 1000 milisecond interval plus or minus MARGIN */

main(){
    register int time_now;
    register int time_before;
    register int time_diff;
    register unsigned char clap_count;

    for (;;) {
        time_before = clap_count = 0;
        while (clap_count < 3) {
            await_clap();
            time_now = get_time(); /* in miliseconds */
            time_diff = time_now - time_before;
            if (1000-MARGIN < time_diff && time_diff < 1000+MARGIN) {
                ++clap_count;
                }
            else {
                clap_count = 0;
                }
            time_before = time_now;
            }
        beep();
        }
    }
```

Fig 1—Representing the machine-independent portion *of a program for an electronic key-finder, this simple algorithm distinguishes between random noise and a precisely timed series of hand claps. You can compile and run this sample program on a Unix host computer or on a target system's single-chip µP.*

Coding conventions overcome 8051 incompatibility

The unusual architecture and instruction set of the 8051 single-chip μP make it awkward to program in C. Nonetheless, you can program the 8051 in C and realize the benefits mentioned in the main text if you adhere to the following four C programming conventions:

- Make heavy use of register declarations.
- Follow a naming convention for variables residing in the different memory spaces.
- Use macros to dereference pointers explicitly.
- Declare global variables as external in all but, at most, one file.

Because the instruction set of the 8051 is very inefficient at accessing both external memory and local variables on the stack, the compiler supports many register variables. The compiler allocates these register variables to a set of internal RAM locations referred to as pseudoregisters (some of which are mapped onto physical registers r0 through r7). The first coding convention strongly advises that most C expressions involve only register variables.

On the 8051, C variables that aren't of storage class "register" or "automatic"—ie, variables kept in registers or on the stack—can reside at the same address in one of the three address spaces: internal RAM, external RAM, or ROM. The 8051 uses distinct machine instructions to access a variable according to its location, but there is no denotation in standard C that can tell the compiler where a variable resides.

The second coding convention solves this problem by requiring that you append a prefix to a variable that denotes its proper address space. For example, Xcount resides in external RAM, and Ctable resides in code ROM. Variables lacking one of these prefixes are in internal RAM. During compilation, the stream editor implants the proper instruction, depending on the prefix of the variable, into the assembly-language file.

*(Ed Note: Unlike most high-level languages, C employs prefixes to modify the meaning of a variable. Simply using the variable I in a C program yields the contents of the variable's location. Appending an ampersand, &I, returns the address of the variable's location, and appending an asterisk, *I, treats the contents of I as a pointer to another location. Although the appending of the ampersand has no specific name, some programmers refer to the action of obtaining the value pointed to by a pointer as "dereferencing" the pointer.)*

Not so easily circumvented is the problem of dereferencing pointers. Here the appending solution will not work because, though the pointer has a name, the pointer's value does not. Consider the pointer P=7. The compiler cannot tell whether *P refers to the contents of address 7 in ROM, internal RAM, or external RAM.

C preprocessor solves puzzle

Because the compiler cannot generate code to dereference pointers automatically, you must explicitly dereference each pointer into a nondefault address space. The C preprocessor can render this dereferencing machine independent. You can write macros that call an appropriate dereferencing routine on the 8051, or that just do the usual C dereferencing on the Unix host. You'll need 8- and 16-bit versions of the macros shown in **Fig A** for each supported address space.

The use of these macros is an application of the third coding convention. The fourth coding convention—declaring all but one of the global variables as external—comes into play because the linker does not resolve multiple declarations of the same variable.

```
#if vax|sun
#  define GET8C(p)      (*p)          /* get byte from ROM */
#  define PUT8X(p,v)    (*(p)=(v))    /* put byte to external RAM */
#else
#  define GET8C(p)      get8c(p)      /* get byte from ROM */
#  define PUT8X(p,v)    put8x(p,v)    /* put byte to external RAM */
#endif
```

Fig A—Eight- and 16-bit versions of these macros *will call the appropriate routines that "dereference" the pointers in your 8051 program code.*

```
                          ! start of segment 0
                                  text
                          ! main(){
                                  global  _main
t0000                     _main
                                  !--- opt #5i saves 3
t0000 3C                          pshx
t0001 3C                          pshx
t0002 3C                          pshx
t0003 34                          des
                          ! register int time_now;
                          ! register int time_before;
                          ! register int time_diff;
                          ! register unsigned char clap_count;
                          ! for (;;) {
t0004                     L15
                          ! time_before = clap_count = 0;
t0004 5F                          clrb
t0005 30                          tsx
t0006 E7 06                       stab    6+0+T1,x
t0008 4F                          clra
t0009 ED 02                       stad    2+0+T1,x
                          ! while (clap_count < 3) {
t000B                     L16
t000B 30                          tsx
t000C E6 06                       ldab    6+0+T1,x
t000E C0 03                       subb    #<3
t0010 24 29                       jcc     L17
                          ! await_clap();
t0012 BD e0000                    jbs     _await_clap
                          ! -- line 20 "main.c"
                          ! time_now = get_time();
t0015 BD e0000                    jbs     _get_time
t0018 30                          tsx
                                  !--- opt #1a saves 2
t0019 ED 00                       stad    0+0+T1,x
                          ! time_diff = time_now - time_before;
t001B A3 02                       subd    2+0+T1,x
                                  !--- opt #1a saves 2
t001D ED 04                       stad    4+0+T1,x
                          ! if (1000-50 < time_diff && time_diff < 1000+50) {
```

that task is still before you. Second, the compiler-generated assembly language will not look as familiar as your own hand-generated assembly language even if you are familiar with your single-chip μP's instruction set.

In spite of these disadvantages, the versatility of C compiling remains attractive. A simple example demonstrates how you can code and debug the majority of an application in C. The example is a program for a key-finder, which is a commercially available product, found in novelty shops and catalogs, for people who habitually misplace their keys. It's built into a key ring and continuously listens for four consecutive, precisely timed hand claps. When it detects the four percussive sounds at 1-sec intervals, it beeps for a few seconds, signaling its location to the key-seeker. When the key-finder hears improperly timed sounds, it presumes they represent random noise and it resets.

Fig 1 shows the main algorithm. This code, depending on how it's compiled, can run both on a Unix host and on the key-finder hardware. Notice that no specific hardware is referred to; you need only simulate the software interface. **Fig 2** shows what the main algorithm looks like after compilation and assembly for the Hitachi 6301. You can also compile these files without change for the Intel 8051. (See **box,** "Coding conventions overcome 8051 incompatibility.")

The underlying hardware, which would include a μP and associated audio I/O transducers and drive circuitry, is not directly referred to in the compiled and

```
t001F 83 03B6                   subd    #950
t0022 0A                        clv
t0023 2F 0B                     jle     L20
t0025 EC 04                     ldad    4+0+T1,x
t0027 83 041A                   subd    #1050
t002A 2A 04                     jpl     L20
                        ! ++clap_count;
t002C 6C 06                     inc     6+0+T1,x
                        ! }
                        ! else {
t002E 20 04                     jbr     L21
t0030                   L20
                        ! clap_count = 0;
t0030 5F                        clrb
t0031 30                        tsx
t0032 E7 06                     stab    6+0+T1,x
                        ! }
t0034                   L21
                        ! time_before = time_now;
t0034 30                        tsx
t0035 EC 00                     ldad    0+0+T1,x
t0037 ED 02                     stad    2+0+T1,x
                        ! }
t0039 20 D0                     jbr     L16
t003B                   L17
                        ! beep();
t003B BD e0000                  jbs     _beep
                        ! }
t003E                   L13
t003E 20 C4                     jbr     L15
t0040                   L14
                        ! }
t0040                   L12
                                !--- opt #6i saves 3
t0040 38                        pulx
t0041 38                        pulx
t0042 38                        pulx
t0043 31                        ins
t0044 39                        rts
      0000              T1      equ     0
      0007              F1      equ     7
```

Fig 2—After compiling the program in Fig 1 for the 6301 µP, *the C compiler produces this listing. Note that the compiler mixes high-level and assembly-level statements as a debugging aid.*

assembled code. Also not referred to is the µP-specific initialization code that sets up the timers, stack pointer, and interrupt vectors and initiates execution of the C program. What's more, the program doesn't show the timer-interrupt routine (which might also be written in C), because its implementation is hardware specific. Simulating these hardware-specific functions is the key to developing single-chip-µP programs in C on a host computer.

Program fragments stand in

Fig 3a shows some hardware-simulation "stubs." These stubs are program fragments written solely for debugging on the Unix host and are throwaway code. They are stand-ins for hardware-specific code. Notice that, for the Unix simulation, the key-finder will not actually beep, but instead will print the word "beep" every time the algorithm detects the proper sequence of claps. Similarly, instead of listening for hand claps—something most Unix computers can't do—pressing the return key simulates hands clapping.

The problem of simulating the timer's interrupts is somewhat more complicated than the two preceding simulations. **Fig 3b** shows that a simple background task can write an integer representing elapsed time into a file, updating the number periodically (on many versions of Unix, "periodically" means 1-sec intervals). Then the key-finder program need only read the file whenever it wants to know the time elepsed. This scheme effectively simulates a time variable maintained

Text continued on pg 222

```
#if   i8051|h6301
#else i8051|h6301

/*
 * Unix simulation of hardware details
 */

beep(){
    printf("beep\n");
    }

/* typing return simulates detection of a hand clap */
await_clap(){
    getchar();
    }

/* assume that the program below is updating file "./timer" in the background */
get_time(){
    int time;
    int fd;

    fd = open("timer", 0);
    if (fd <= 0) {
        printf("couldn't open timer\n");
        }
    while (read(fd, &time, sizeof(int)) != sizeof(int));
    close(fd);
    return time;
    }

#endif i8051|h6301
```

(a)

```
 *
 * Example program which runs in the background to simulate the interrupt
 * routine which maintains the value of the "time" variable below.
 *
 * Every second, a new value is written into file "./time" to be read by
 * get_time() above.  The value is in miliseconds.
 */
# include <sys/file.h>
main(){
    int fd;
    int time;
    for (;;) {
        fd = open("timer",O_WRONLY|O_CREAT,0644);
        write(fd,&time,4);
        close(fd);
        time = time + 1000;
        sleep(1);
        }
    }
```

(b)

*Fig 3—**If you run the program in Fig 1** on a Unix host, you'll need some program stubs **(a)** to stand in for the target-system hardware and a simple background task **(b)** to represent elapsed time. Simulation of the missing hardware is the key to debugging single-chip-µP programs on a Unix host computer.*

The number of lines of C code needed to express an algorithm will be fewer than the number of lines of assembly language required.

```
#if i8051|h6301

/*
 * Hypothetical microprocessor hardware interface:
 */

extern unsigned char Xmike; asm("_Xmike equ 0x1000");
extern unsigned char Xhorn; asm("_Xhorn equ 0x1001");

/*
 * assume memory mapped output location "Xhorn" is connected to a loudspeaker
 */
beep(){
    register unsigned int cycles;

    for (cycles=2000; cycles; --cycles) { /* create 2000 cycles of tone */
        Xhorn=0x01;     /* waveform high */
        delay();
        Xhorn=0x00;     /* waveform low */
        delay();
        }
    }

delay(){
    register unsigned char delay;

    for (delay=255; delay; --delay);
    }

/*
 * assume an interrupt routine is updating the value of memory location "time"
 */
unsigned int Xtime;
#define get_time() Xtime        /* just use the value */

/*
 * assume memory mapped input location "Xmike" is connected to microphone
 * hardware such that bit 1 goes low when a clap is detected.
 */
await_clap(){
    while ((char)(Xmike&0x01));
    return;
    }

#else i8051|h6301
```

Fig 4—When you download Fig 1's compiled code *to your target system, you'll have to replace the stubs in* ***Fig 3*** *with machine-dependent code similar to the routines in this figure.*

FREE!

Here's the data you need on AC power for ATE systems, laboratories, test facilities, robotics, quality control, data processing and more. It's all in our new full color catalog that features hundreds of AC Power Sources and Uninterruptible Power Systems. Call or write for your free copy.

(805) 684-8311 COLLECT

BEHLMAN
Engineering
Electronic Energy Conversion Sources & Systems

1142 Mark Avenue
Carpinteria, CA 93013

CIRCLE NO 122

This publication is available in microform.

University Microfilms International reproduces this publication in microform: microfiche and 16mm or 35mm film. For information about this publication or any of the more than 13,000 titles we offer, complete and mail the coupon to: University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106. Call us toll-free for an immediate response: 800-521-3044. Or call collect in Michigan, Alaska and Hawaii: 313-761-4700.

☐ Please send information about these titles:

Name
Company/Institution
Address
City
State Zip
Phone ( )

University
Microfilms
International

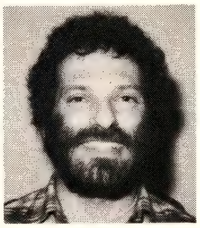
by a timer-interrupt routine in the actual key-finder's hardware.

Fig 4 shows hypothetical, µP-specific code that detects claps, generates beeps, and gets the elasped time. You would need to substitute routines like these for the stubs in **Fig 3** before the program could run in the target hardware. The code assumes that memory-mapped output location Xhorn has its least-significant bit wired to a loudspeaker. The beep function creates a tone by toggling the level on this output port. Similarly, audio-input hardware detects a sufficiently loud clap as a change in the level of the least-significant bit of the memory-mapped input location, Xmike.

Where a function call, get_time(), could return the value of the timer variable, you can use a C preprocessor macro instead, as **Fig 4** shows. The macro presents the same software interface as a function call, but it has no function-call overhead. This approach is a subtle but useful trick of the trade. As shown, the get_time macro is exactly equivalent to a direct reference to the variable Xtime that the target's hardware would maintain.

EDN

Author's biography



Corey Satten is presently a senior software engineer and is responsible for software technology at John Fluke Mfg Co Inc. In that capacity, he designed the compilers described in this article. He received a BS in electrical engineering and an MS in computer science from UCLA. In his spare time, he enjoys backpacking and metal sculpting.

References

1. Johnson, Steve, "The Evolution of the Portable C Compiler," paper presented at the 1984 Uniforum Conference, Washington, DC.

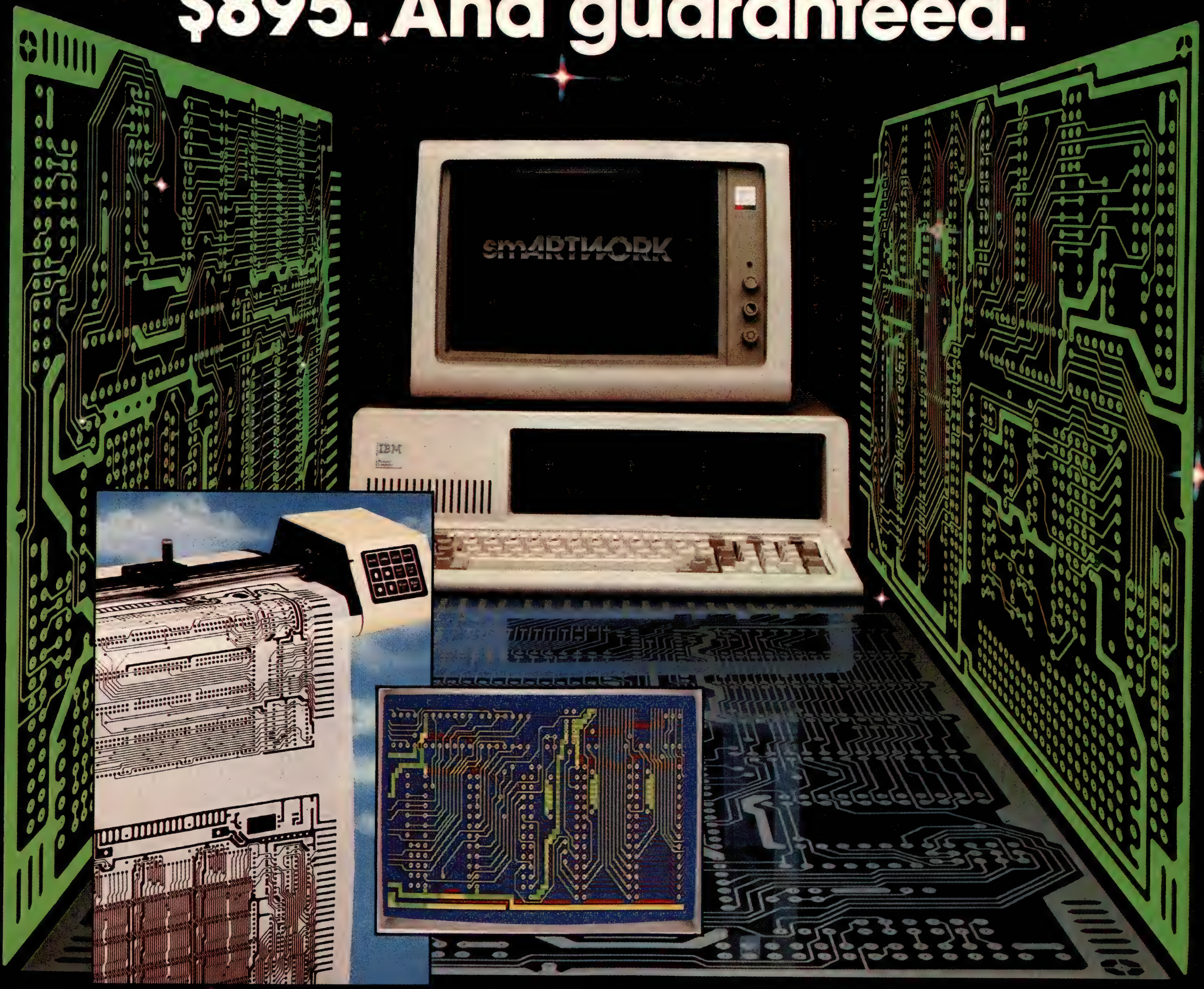
2. *Hitachi 8-bit Single-chip Microcomputer Data Book #U71*, Hitachi America Ltd, San Jose, CA, 1985.

3. Kernighan, B W, and Ritchie, D M, *The C Programming Language*, Prentice-Hall, Englewood, NJ, 1978.

4. Wharton, John, *An Introduction to the Intel MCS-51 Single-Chip Microcomputer Family*, Intel Corp, Santa Clara, CA, 1980.

Article Interest Quotient (Circle One)
High 482 Medium 483 Low 484

Circuit-Board-Artwork Software: $895. And guaranteed.



smARTWORK® lets the design engineer create and revise printed-circuit-board artwork on the IBM Personal Computer. You keep complete control over your circuit-board artwork — from start to finish.

And smARTWORK® is reliable. When we couldn't find a package that was convenient, fast, and affordable, we created smARTWORK® to help design our own microcomputer hardware. We've used it for over two years, so we know it does the job.

That's why we offer every design engineer *a thirty-day money-back no-nonsense guarantee.*

smARTWORK® advantages:

☐ Complete interactive control over placement and routing
☐ Quick correction and revision
☐ Production-quality 2X artwork from a pen-and-ink plotter
☐ Prototype-quality 2X artwork from a dot-matrix printer
☐ Easy to learn and operate, yet capable of sophisticated layouts
☐ Single-sided and double-sided printed circuit boards up to 10 x 16 inches
☐ Multicolor or black-and-white display

System Requirements:

☐ IBM Personal Computer, XT, or AT with 320K RAM, 2 disk drives, and DOS Version 2.0 or later
☐ IBM Color/Graphics Adapter with RGB color or black-and-white monitor
☐ IBM Graphics Printer or Epson FX/MX/RX series dot-matrix printer
☐ Houston Instrument DMP-41 pen-and-ink plotter
☐ Microsoft Mouse (optional)

The Smart Buy

At $895, smARTWORK® is proven, convenient, fast — *and guaranteed.* Call us today. And put smARTWORK® to work for yourself next week. Try it for 30 days at absolutely no risk. That's smart work.

Wintek Corporation
1801 South Street
Lafayette, IN 47904-2993
Telephone: (317) 742-8428
Telex: 70-9079 WINTEK CORP UD

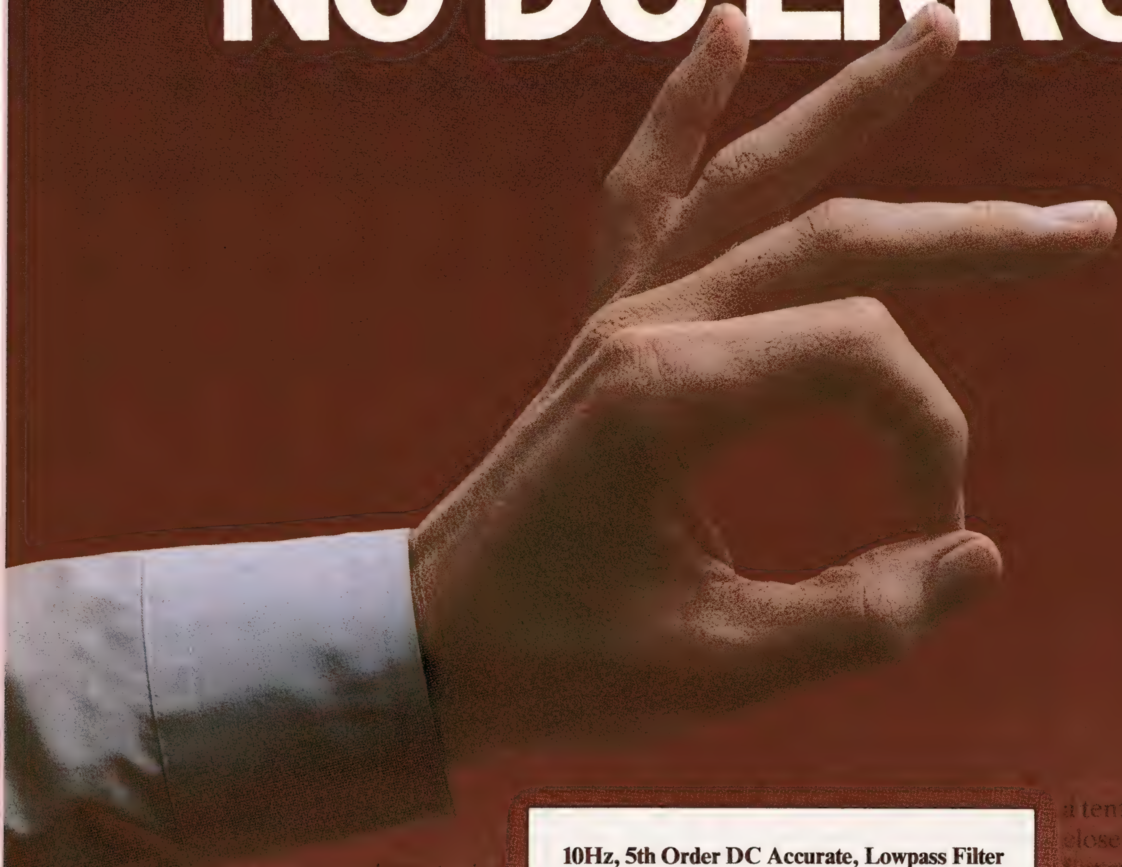
WINTEK®

In Europe contact: RIVA Terminals Limited, Woking, Surrey GU21 5JY ENGLAND, Telephone: 04862-71001, Telex: 859502

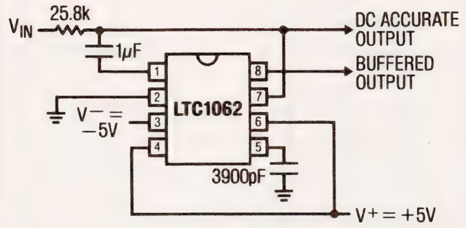
"smARTWORK", "Wintek" and the Wintek logo are registered trademarks of Wintek Corporation.

CIRCLE NO 123

NEW FILTER. NO DC ERROR.



10Hz, 5th Order DC Accurate, Lowpass Filter



- 60µV NOISE IN THE PASSBAND, 100µV WIDEBAND NOISE.
- −80dB TOTAL HARMONIC DISTORTION (THD).
- INPUT R,C ALSO ACTS AS AN ANTI-ALIASING FILTER.

Introducing an active approach to passive filters. The LTC1062 from Linear Technology is a fifth order, all-pole, maximally flat lowpass filter with *no DC error.* The filter's unique architecture puts the active circuitry outside the DC signal path, so DC offset voltage errors and low frequency noise are eliminated.

LTC1062 is a revolutionary new product because it uses an existing, refined switched capacitor technology in a new way. It combines the DC accuracy of a simple resistor-capacitor filter with the filtering performance of a complex network.

The LTC1062 can make a significant contribution where DC accuracy is important. With the LTC1062, you get low passband noise, −80dB distortion, no aliasing, and fifth order filtering in an economical eight-pin, dual in-line package. Cascading two units forms a tenth order lowpass filter that closely approximates maximally flat response.

The filter's wide (90dB) signal-to-noise ratio is ideal for data acquisition applications demanding low passband noise. The LTC1062's operation at up to 20kHz cutoff frequency makes it a good choice for audio circuits. And it's easy to use because there's no need to know filter synthesis to apply it.

The message is simple. *New filter. No DC error.* And the LTC1062 is just one member of an entire filter family. LTC1059/1060 and 1061 single, dual and triple precision, high-performance universal filters are also available.

In quantities of 100, the commercial version (−40°C to +85°C) of the LTC1062CN8 is $3.55 each. The military version, LTC1062MJ8, is $7.00 each in similar quantities. For technical data sheets, contact: LINEAR TECHNOLOGY CORPORATION, 1630 McCarthy Blvd., Milpitas, CA 95035. (408) 942-0810.

LINEAR
TECHNOLOGY

TOUGH PRODUCTS
FOR TOUGH APPLICATIONS.

CIRCLE NO 124

DESIGN IDEAS

EDITED BY TARLTON FLEMING

Generator varies pulse delay and duration

Dil Sukh Jain
National Remote Sensing Agency,
Hyderabad, India

Using a flip-flop and two one-shots (dual monostable multivibrators), you can delay a pulse train for an interval as long as the time between pulses while independently controlling the output-pulse duration **(Fig 1)**.

One-shots IC_{1A} and IC_{2A} trigger on the input signal's leading and trailing edges, respectively. As a result, the Q_1 outputs go high for an interval (t_D in this case) set by the adjustable resistors R_1 and R_2. In turn, these positive pulses cause narrow negative-going pulses at the $\overline{Q_2}$ outputs of one-shots IC_{1B} and IC_{2B}, which set and reset the flip-flop, IC_3, to produce an output signal.

Because R_1 and R_2 are set for the same delay time, t_D, the output is a delayed replica of the input. As an alternative, you can use R_1 to delay the pulse train and use R_2 to control the pulse duration. **EDN**

To Vote For This Design, Circle No 747

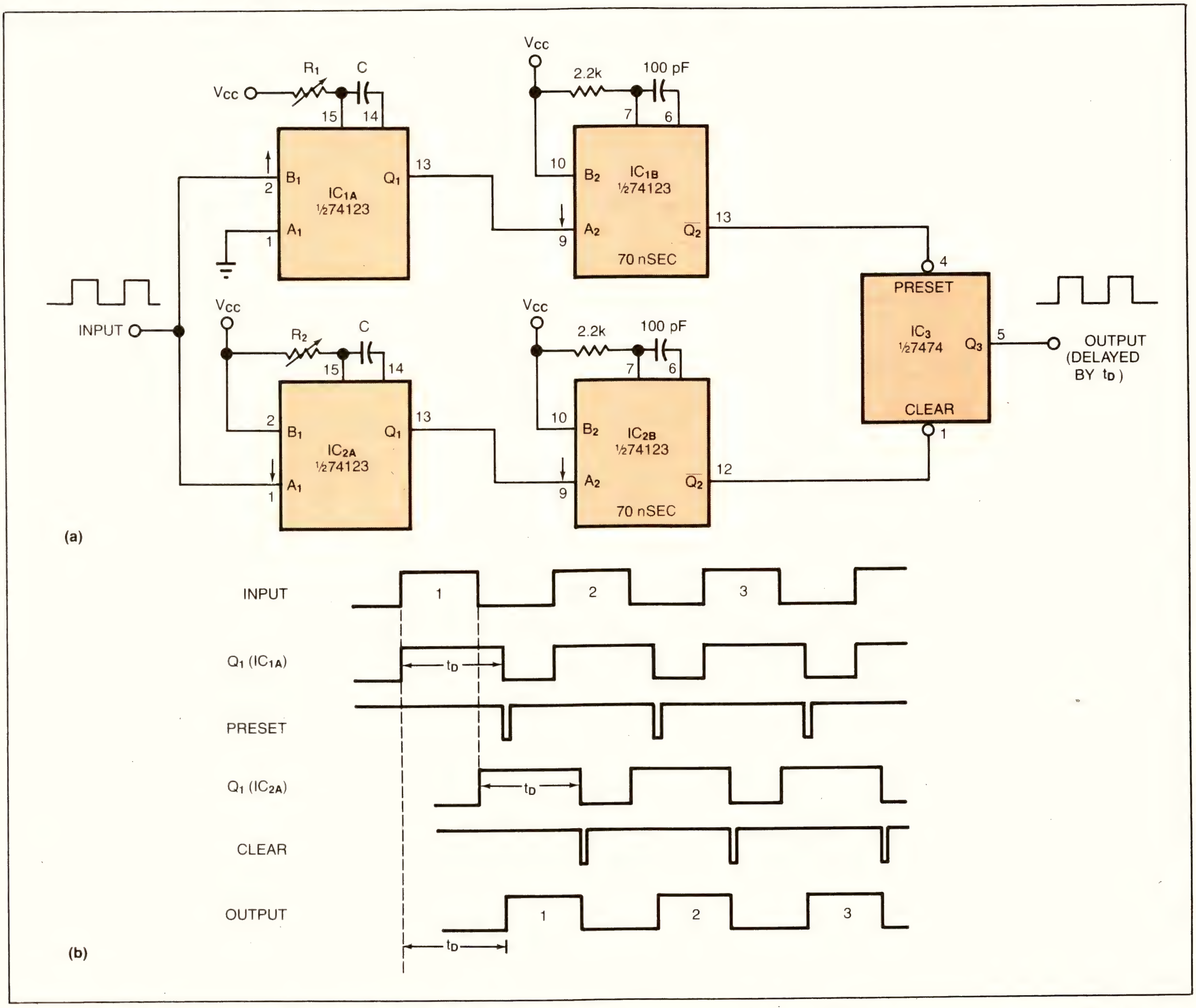


*Fig 1—You can independently control the output pulse duration and delay via R_1 and R_2 **(a)**. If both potentiometers are set for the same delay as shown, the output is a delayed replica of the input **(b)**.*

Solid-state switch offers fast interrupt

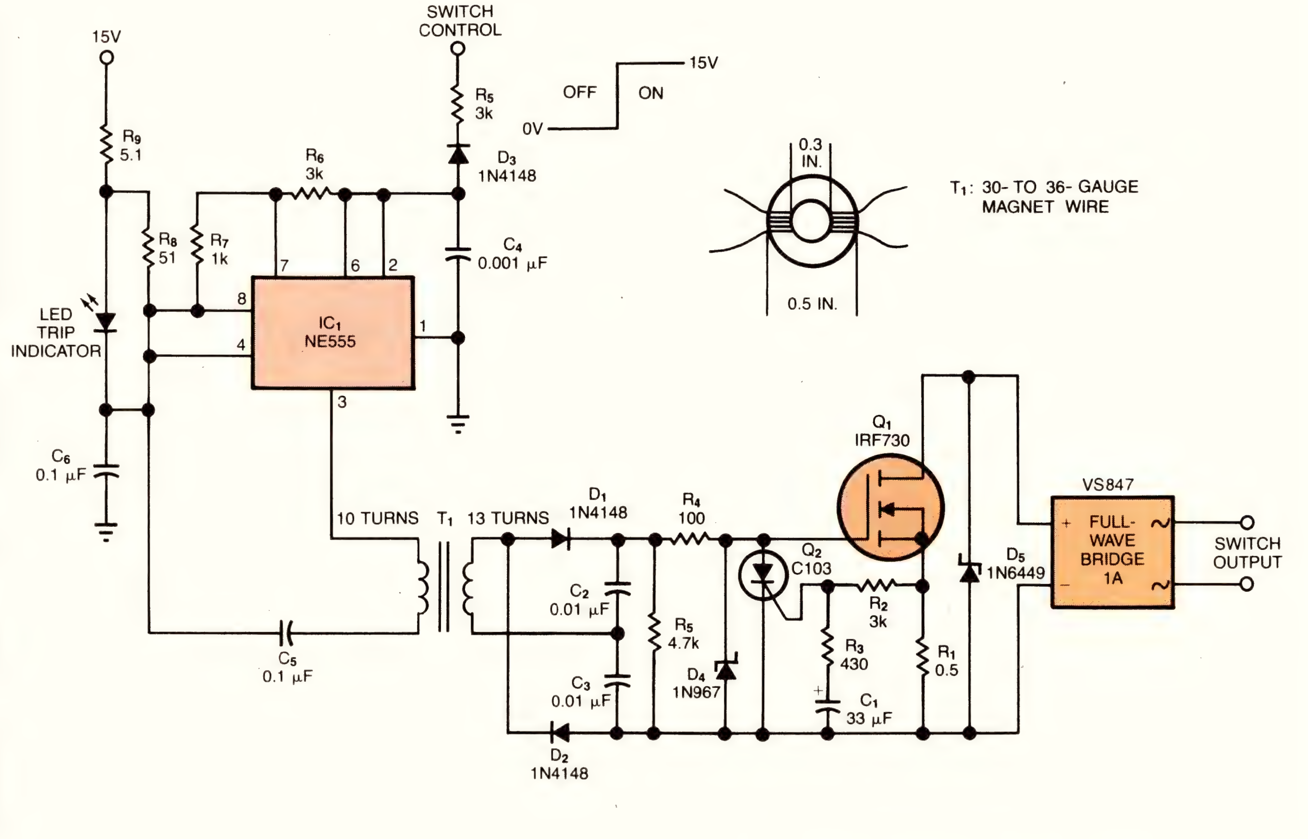
Geoffrey N Drummond
Hughes Aircraft, Torrance, CA

Based on a diode bridge and a VMOS power transistor (Q_1), a solid-state switch **(Fig 1)** acts as a circuit breaker, sensing and interrupting an overcurrent condition within 2 μsec. The circuit's isolation transformer, T_1, allows the switch to float. The components shown are capable of handling 1A rms or 8A pk. However, if your application requires the handling of more current, you can change R_1, Q_1, and the bridge.

Compared with a thyristor, a VMOS transistor has higher saturation voltage—6 to 10V—and is less rugged—peak- to continuous-current ratio is about 4:1, vs 20:1 for a thyristor. To protect the MOSFET in the case of fault conditions, SCR Q_2 exerts a crowbar action on the Q_1 gate, minimizing power dissipation by forcing the transistor to turn off rapidly. The 555 timer forms an astable multivibrator that drives T_1 at 150 kHz. A full-wave voltage doubler at the T_1 secondary then provides 15V to the Q_1 gate, which turns on the transistor and switch for normal operation.

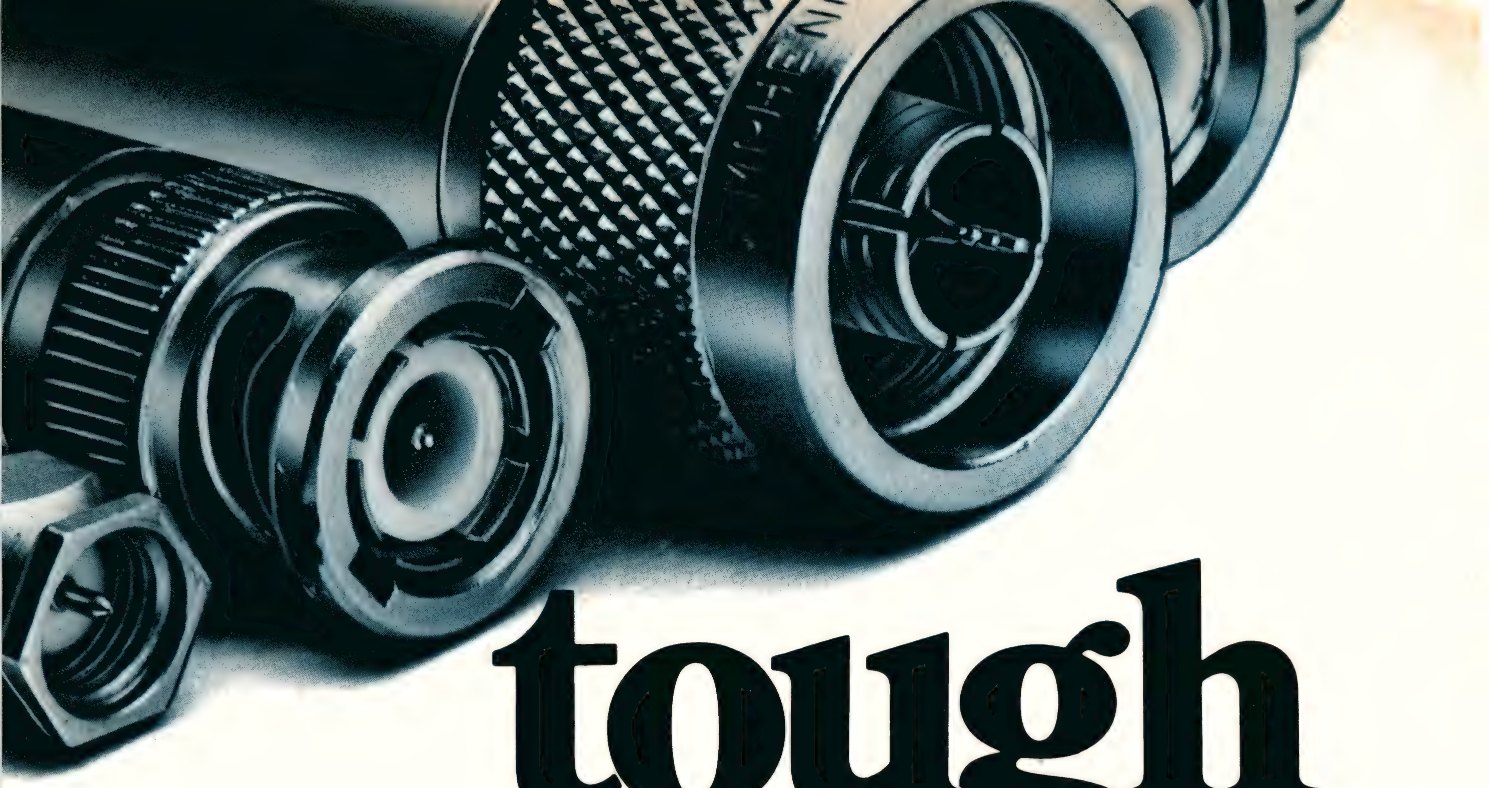
Three overcurrent conditions will short circuit the transistor and turn off the switch. First, if resistor R_1 senses excessive steady-state rms current, it will cause the switch to open at a threshold of $R_1 = 0.6V/I$ rms.

Second, the circuit will accommodate time-variant currents (such as those encountered in a lamp or motor,



NOTES:
1. ALL RESISTORS EXCEPT R_1 ARE ¼W CARBON.
2. T_1 IS A FERROXCUBE 204XT250-3E2A.

Fig 1—A floating, isolated solid-state switch *interrupts fault currents in about two microseconds.*



tough attenuators

from $11.95 (1-49)

one-piece design defies rough handling

Check these features:

- ✓ Each unit undergoes high-impact shock test
- ✓ Available from 1 to 40 dB
- ✓ DC to 1500 MHz
- ✓ Unexcelled temperature stability, .002 dB/°C
- ✓ 2W max. input power (SMA is 0.5W)
- ✓ BNC, SMA, N and TNC models
- ✓ Immediate delivery, 1-yr. guarantee

NEW!

Precision 50-ohm terminations... only $6.95 (1-24)
DC to 2 GHz, 0.25W power rating, VSWR less than 1.1
BNC (model BTRM-50), TNC (model TTRM-50)
SMA (model STRM-50), N (model NTRM-50)

*Freq. (MHz)	Atten. Tol. (Typ.)	Atten. Change, (Typ.) over Freq. Range		VSWR (Max.)	
		DC–1000	1000–1500	DC–1000 MHz	1000–1500 MHz
DC-1500 MHz	±0.3	0.6	0.8	1.3	1.5

*DC–1000 MHz (all 75 ohm or 30 dB models) DC-500 MHz (all 40 dB models)

MODEL AVAILABILITY

Model no. = a series suffix and dash number of attenuation.
Example: CAT-3 is CAT series, 3 dB attenuation.
■ denotes 75 ohms; add −75 to model no.
● denotes 50 ohms

ATTEN	SAT (SMA)	CAT (BNC)	NAT (N)	TAT (TNC)
1	●	●	●	●
2	●	●	●	●
3	●	●■	●	●
4	●	●	●	●
5	●	●	●	●
6	●	●■	●	●
7	●	●	●	●
8	●	●	●	●
9	●	●	●	●
10	●	●■	●	●
12	●	●	●	●
15	●	●■	●	●
20	●	●■	●	●
30	●	●	●	●
40	●	●	●	●

PRICING (1-49 qty.): CAT (BNC)..$11.95, SAT (SMA)..$14.95
TAT (TNC)..$12.95, NAT (N)..$15.95

finding new ways ...
setting higher standards

Mini-Circuits
A Division of Scientific Components Corporation
P.O. Box 166, Brooklyn, New York 11235 (718) 934-4500
Domestic and International Telexes: 6852844 or 620156

C 92 REV. B

CIRCLE NO 125

for example) in which the initial surge current is greater than the steady-state current. In this case, capacitor C_1 limits the surge value by setting a limit on the ampere×second product ($I\times t$) for currents between steady state and peak. This threshold is approximately

$$C_1=I\times t\times R_1/(0.6V\times R_2).$$

Third, you can set R_3 to limit the peak current I_P, according to the relation

$$R_3=0.6V\times R_2/(I_P\times R_1-0.6V).$$

After a delay of 0.5 µsec, a peak current causes the switch to open completely in about two microseconds. In addition, the transient suppressor D_5 limits peak voltage to 200V. Once tripped, the switch will remain off until the timer is gated off (Switch Control), or until you remove the timer's power for at least one second.

Fig 2b shows the results of a peak-current test (**Fig 2a**). The solid-state switch opened fully in 2.25 µsec; a 1A fast-blow fuse, on the other hand, passed 300A for 10 µsec before opening, which welded the mercury relay's contacts together. **EDN**

To Vote For This Design, Circle No 746

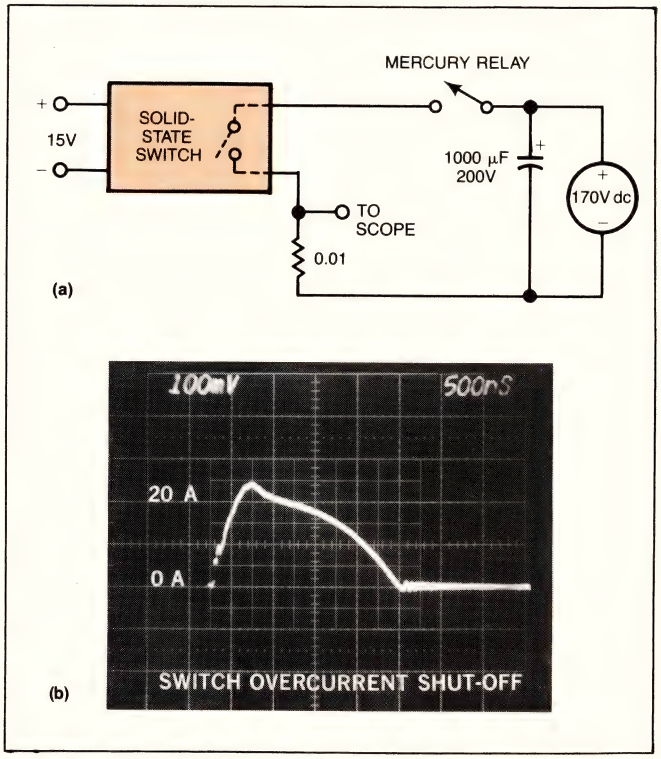


*Fig 2—**This test circuit (a) allows you to measure** the delay and response time of the circuit breaker. The results are presented in **b**.*

Circuit generates frequency difference

Steve Momii
University of Washington, Seattle, WA

Fig 1's output pulse rate equals the difference in pulse rates of the inputs F_0 and F_1, where $F_1<F_0$. (You must generate $2F_0$, but the duty cycle need not be 50%.)

The easiest way to understand the circuit's operation is in terms of sampling theory. Consider the exclusive-OR gate IC_2 as a modulator, in which F_1 modulates the carrier frequency F_0. The resulting waveform contains the sum and difference of F_0 and F_1. By using IC_{1B} to sample this waveform at $2F_0$, you generate an aliasing frequency that folds around the Nyquist frequency F_0; ie, the output difference frequency becomes

$$F_D=2F_0-(F_0+F_1)=F_0-F_1.$$

Of course, variations are posssible. If $F_1=F_0/n$ (using a divide-by-n counter), then $F_D=F_0(1-1/n)$. And, if $F_1=F_0\cdot m/n$ (using a rate multiplier), then $F_D=F_0(1-m/n)$. **EDN**

To Vote For This Design, Circle No 748

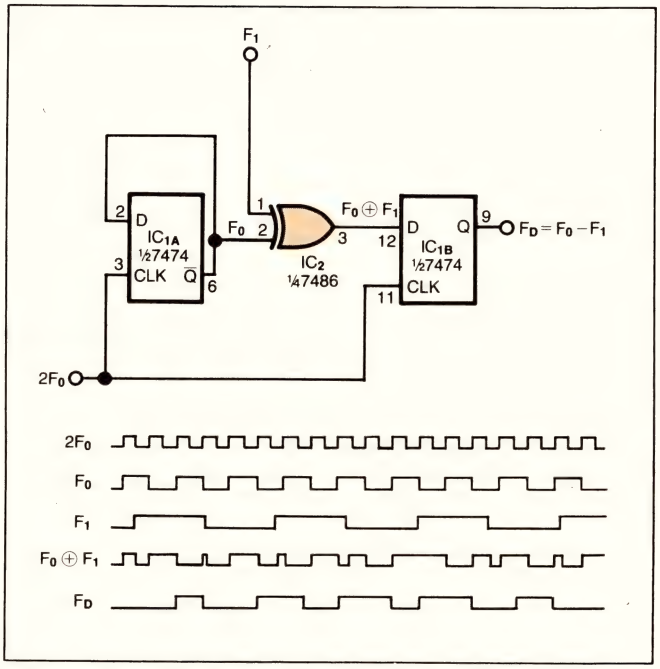
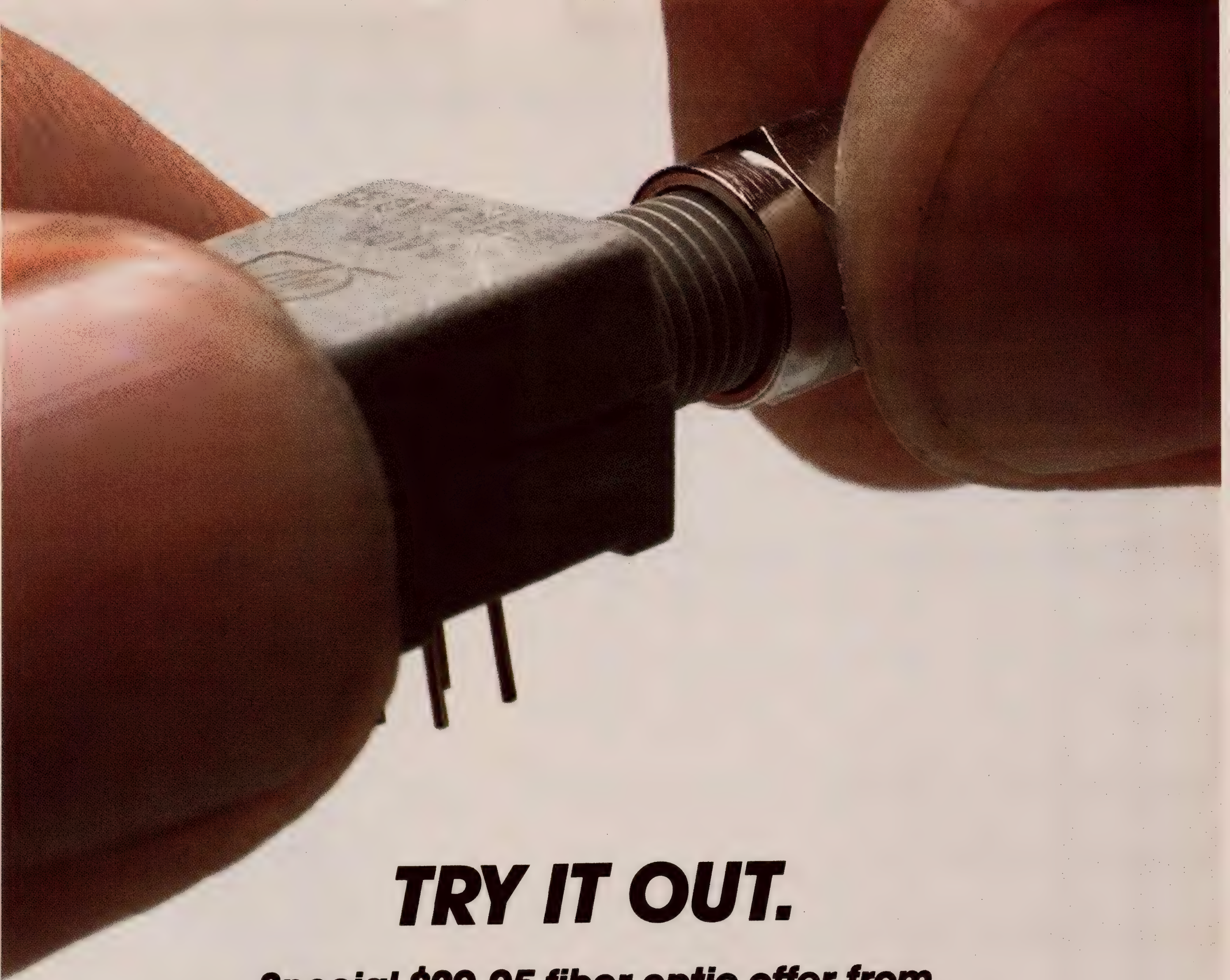


*Fig 1—**Two ICs generate** the frequency difference between F_0 and F_1.*

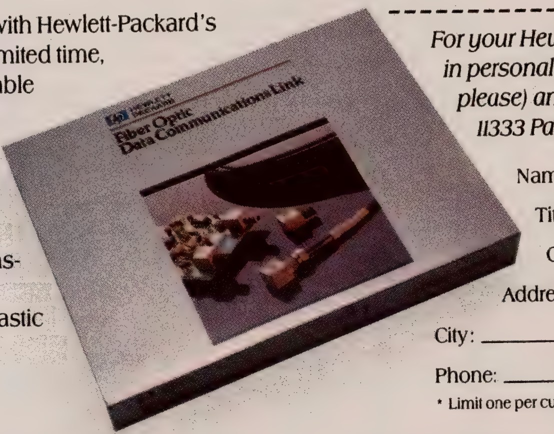


TRY IT OUT.

Special $29.95 fiber optic offer from Hall-Mark and Hewlett-Packard

Get hands-on experience with Hewlett-Packard's quality fiber optic products. Now for a limited time, Hewlett-Packard's fiber optic kit is available at the low price of only $29.95 through Hall-Mark. A $69.00 value, this kit contains:

- Fiber Optic transmitter (HFBR-1402)
- Fiber Optic Receiver (HFBR-2402)
- One plastic tube for housing the transmitter and receiver
- Two meters of SMA connectored, plastic fiber optic cable
- Data sheet describing kit features
- 20-page Fiber Optic data sheet



For your Hewlett-Packard fiber optic kit, send $29.95 in personal check or money order (no cash please) and this coupon to: Hall-Mark Electronics, 11333 Pagemill, Dallas, TX 75243, Attn: DC-13.

Name: ____________________

Title: ____________________

Company: ____________________

Address: ____________________

City: ____________ State: ________ Zip: ________

Phone: ________ Application: ____________

* Limit one per customer.

EDN62686

Alabama
Huntsville (205) 837-8700
Arizona
Phoenix (602) 437-1200
California
Bay Area (408) 946-0900
Orange County (714) 669-4700
Sacramento (916) 722-8600
San Diego (619) 268-1201
San Fernando Valley (818) 716-7300
West Los Angeles (213) 217-8400

Colorado
Denver (303) 790-1662
Connecticut
Connecticut (203) 269-0100
Florida
Ft. Lauderdale (305) 971-9280
Orlando (305) 855-4020
Tampa Bay (813) 530-4543
Georgia
Atlanta (404) 447-8000
Illinois
Chicago (312) 860-3800

Indiana
Indianapolis (317) 872-8875
Kansas
Kansas City (913) 888-4747
Maryland
Baltimore (301) 988-9800
Massachusetts
Boston (617) 935-9777
Minnesota
Minneapolis (612) 941-2600
Missouri
St. Louis (314) 291-5350

New Jersey
Fairfield (201) 575-4415
New York
Long Island (516) 737-0600
North Carolina
Raleigh (919) 872-0712
Ohio
Cleveland (216) 349-4632
Southern Ohio (614) 888-3313
Oklahoma
Tulsa (800) 231-0253

Pennsylvania
Philadelphia (215) 355-7300
Texas
Austin (512) 258-8848
Dallas (214) 553-4300
Houston (713) 781-6100
Utah
Salt Lake City (801) 268-3779
Wisconsin
Milwaukee (414) 797-7844

HALL-MARK
25 YEARS

A COMMITMENT TO EXCELLENCE

© 1986 Hall-Mark Electronics Corp./0220-1005
Hall-Mark Electronics Corp. is a subsidiary of the Tyler Corp.

CIRCLE NO 126

EPROMs simplify TMS32010 memory system

A D E Brown
British Aerospace, Stevenage, Hertfordshire, UK

Systems based on the TMS32010 signal-processing μP usually include a 4k×16-bit static RAM. Nevertheless, if your application permits, you can operate the μP with two TMS2532-30 EPROMs instead. You must run the TMS32010 at a slower clock speed (say, 10 MHz) rather than the full 25 MHz attainable with a static RAM. And obviously you can't write to an EPROM, so the code executed must not include table-write (TBLW) instructions.

You download the TMS32010's assembled object code from a development system or XDS-22 emulator to an EPROM programmer that allows the storage of even and odd bytes in separate devices (GP Industries' XP640 or a Stag's PP39, for example). This way, one EPROM holds the most significant bytes and the other EPROM holds the least significant bytes **(Fig 1).** Both EPROMs are connected in parallel to the TMS32010's buffered address bus. Besides reducing the memory parts count, this arrangement eliminates the boot-loader hardware required to load a RAM system during start-up. **EDN**

To Vote For This Design, Circle No 749

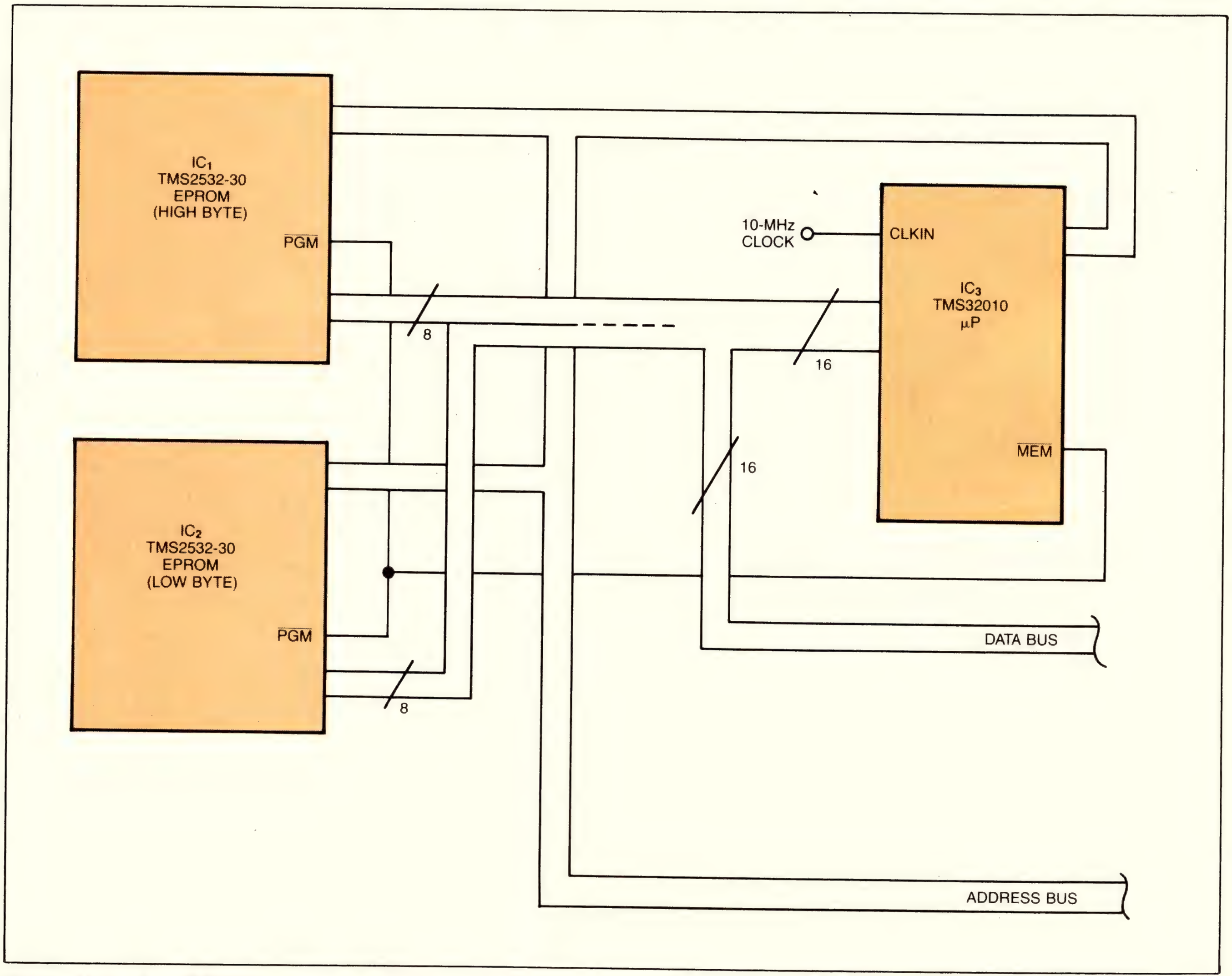
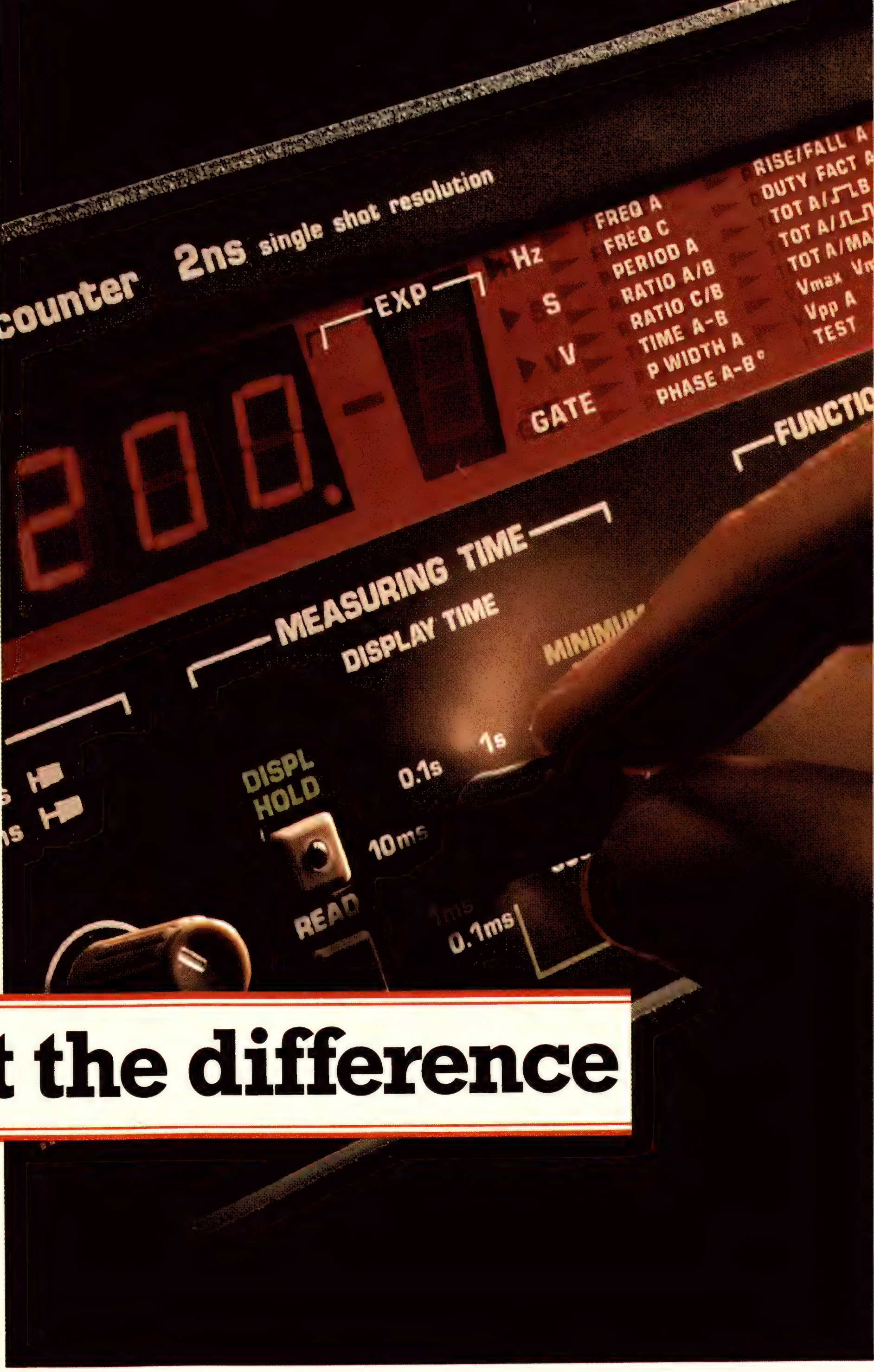


*Fig 1—**Using two EPROMs,** you can simplify a TMS32010 system if your application doesn't require high speed or table-write instructions.*

The unforgettable timer/counters!

The non-volatile EAROM memory in our PM6652 and PM6654 system-oriented timer/counters makes them simply unforgettable. Because it can store up to 8 pre-programmable front-panel menus for fast single-button recall. Yet a good memory is only one of many features:

- 100% IEEE-488 programmability. A microcomputer automates all front-end controls while another speeds up measuring and data handling; both the PM6652 and PM6654 average **over 400 readings per second!**
- High performance. Extremely accurate FREQUENCY and PERIOD measurements: 9 digits (PM6654) or 7 digits (PM6652) at 1s; the PM6652 with conventional 10 MHz/100 ns clock frequency and the PM6654 with a **super-fast 500 MHz/2 ns!**



Test the difference

- Product credibility in technology, technique, quality and service is assured because the PM6652/PM6654 are backed by the corporate resources of one of the world's largest electronics companies.

Test the difference and you'll also agree that Philips wins on price and performance!

Write to: Philips I&E, T&M Department.
Building HKF/55. 5600 MD Eindhoven.
The Netherlands: 040-78 28 08
Germany: (0561) 50 14 96
Great Britain: 0223-35 88 66
France: 01-830 11 11
Belgium: 02-525 111
Switzerland: 01-488 22 11

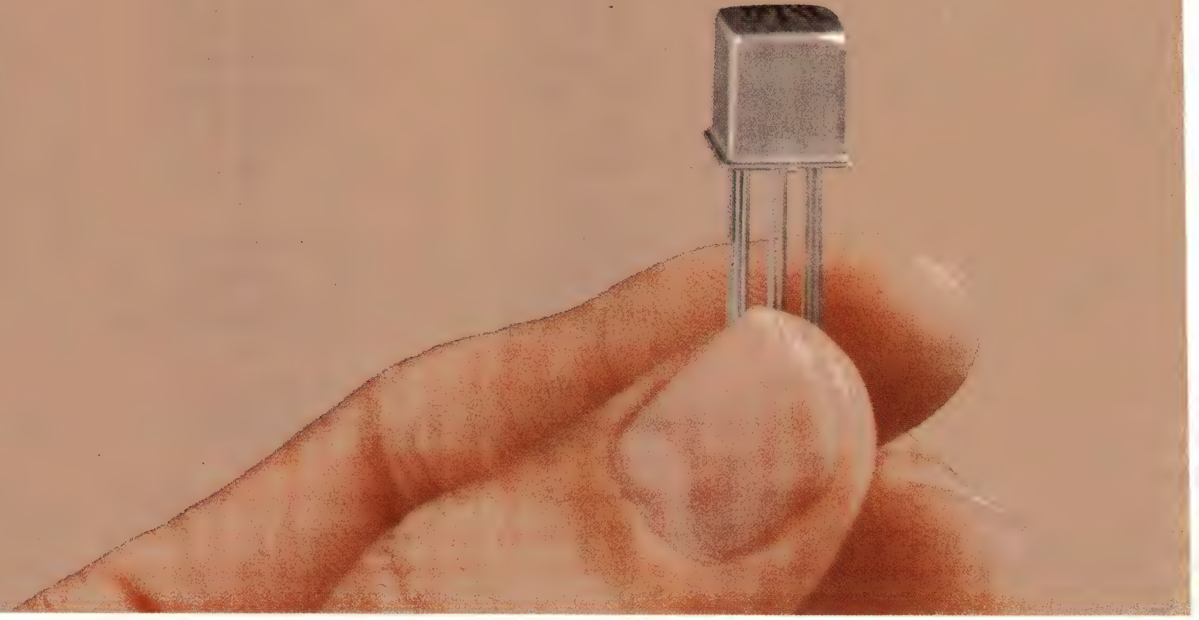
PHILIPS

Test & Measurement

PHILIPS

CIRCLE NO 127

The New 172 Relay We put Centigrid® in civvies to save you money



Now you can have your cake and eat it too! The quality and performance—in fact, the same mechanism as a military TO-5/Centigrid relay at prices you can afford for your commercial designs.

The secret is automation. It permits us to cut costs without cheapening the design. We've designed and built our unique equipment which not only speeds production, but insures quality. For example, our microprocessor-controlled header assembly system automatically tests the subassemblies while they are being produced, cutting down on human error and insuring built-in reliability.

The 172 gives you all the popular Centigrid physical advantages: the rugged uniframe construction; the miniscule .14 sq. in. footprint; the .100 grid lead spacing for direct pc board plug-in without spreader pad, which retains the low .375 in. total profile.

But perhaps even more important, you get all the technical advantages of twenty years of TO-5 leadership: a dependable, low power DPDT relay that has excellent RF characteristics up through UHF, and the proven performance and reliability of TO-5 technology.

If you'd like to know more about how to get military type performance without paying for the uniform, call or write today.

TELEDYNE RELAYS
Innovations In Switching Technology

12525 Daphne Ave., Hawthorne, California 90250 • (213) 777-0077
European Hqtrs: Abraham Lincoln Strasse 38-42, 62 Wiesbaden, W. Germany • 06121-7680
Belgium Sales Office: 181 Chaussee de la Hulpe, 1170 Brussels • (2) 673-99-88
U.K. Sales Office: Heathrow House, Bath Rd., Cranford, Hounslow, Middlesex, TW 5 9QQ • 01-897-2501
Japan Sales Office: Taikoh No. 3 Building, 2-10-7 Shibuya, Shibuya-Ku, Tokyo, 150 Japan • (03) 797-5255

Transistor provides thyristor control

James Zannis
Renishaw Metrology Ltd, New Mills,
Gloucestershire, UK

You can best control thyristors, or SCRs, by applying multiple trigger pulses to the gate during an on period, but this application usually calls for a clock circuit. In **Fig 1,** however, a unijunction transistor Q_1 produces the pulses. The V_{OUT} signal causes a thyristor to turn on once per sync pulse at a phase angle controlled by the potentiometer, R_1.

Each sync pulse causes capacitor C_1 to discharge through Q_2 and causes C_2 to discharge through D_1 and Q_2. These capacitors then recharge through R_1 until node A reaches the unijunction transistor's peak voltage. The transistor fires, which partially discharges C_2; C_2 recharges, producing an output pulse train (picket fence), until the next sync pulse discharges the larger capacitor C_1, causing the cycle to repeat. **EDN**

To Vote For This Design, Circle No 750

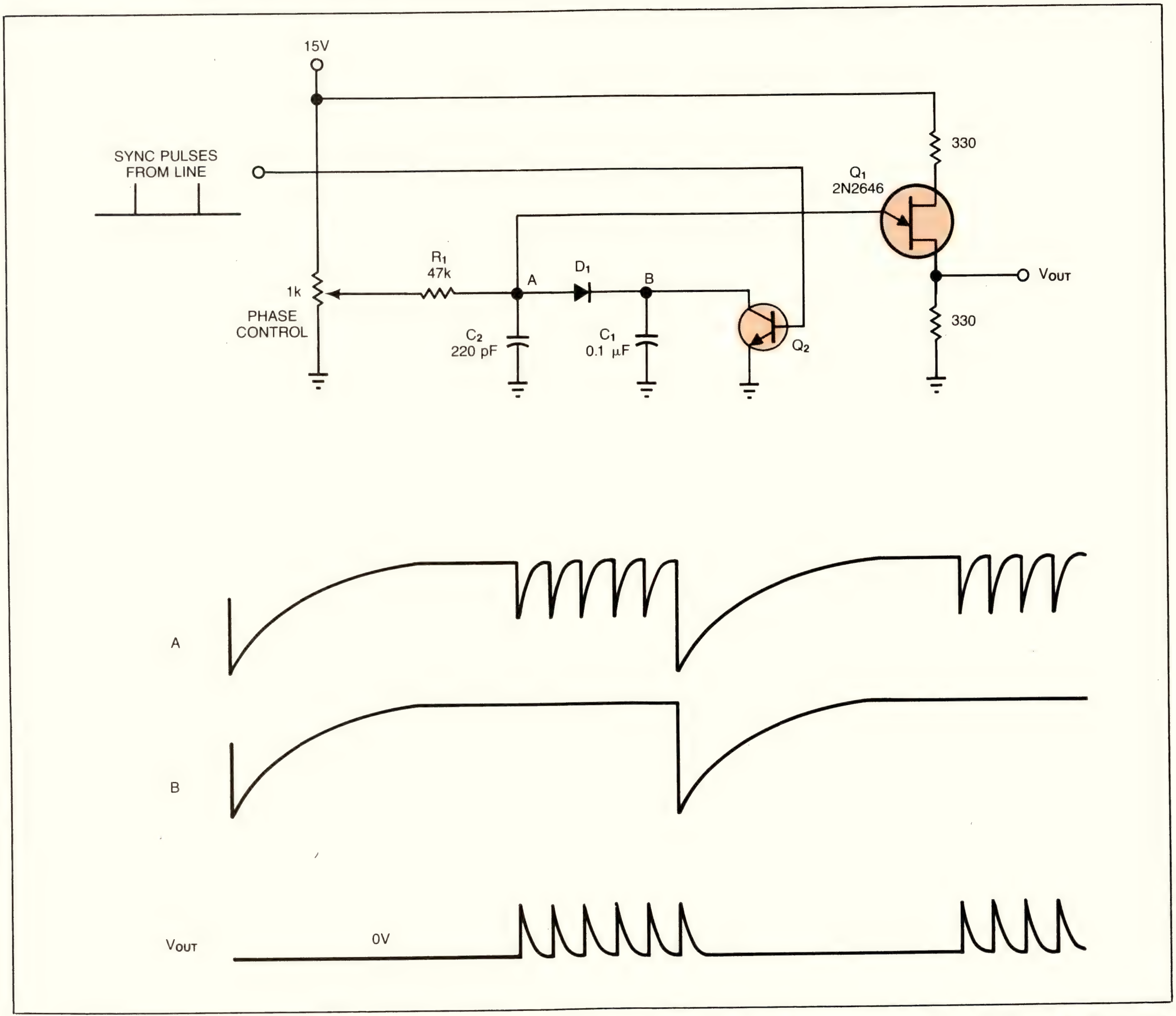
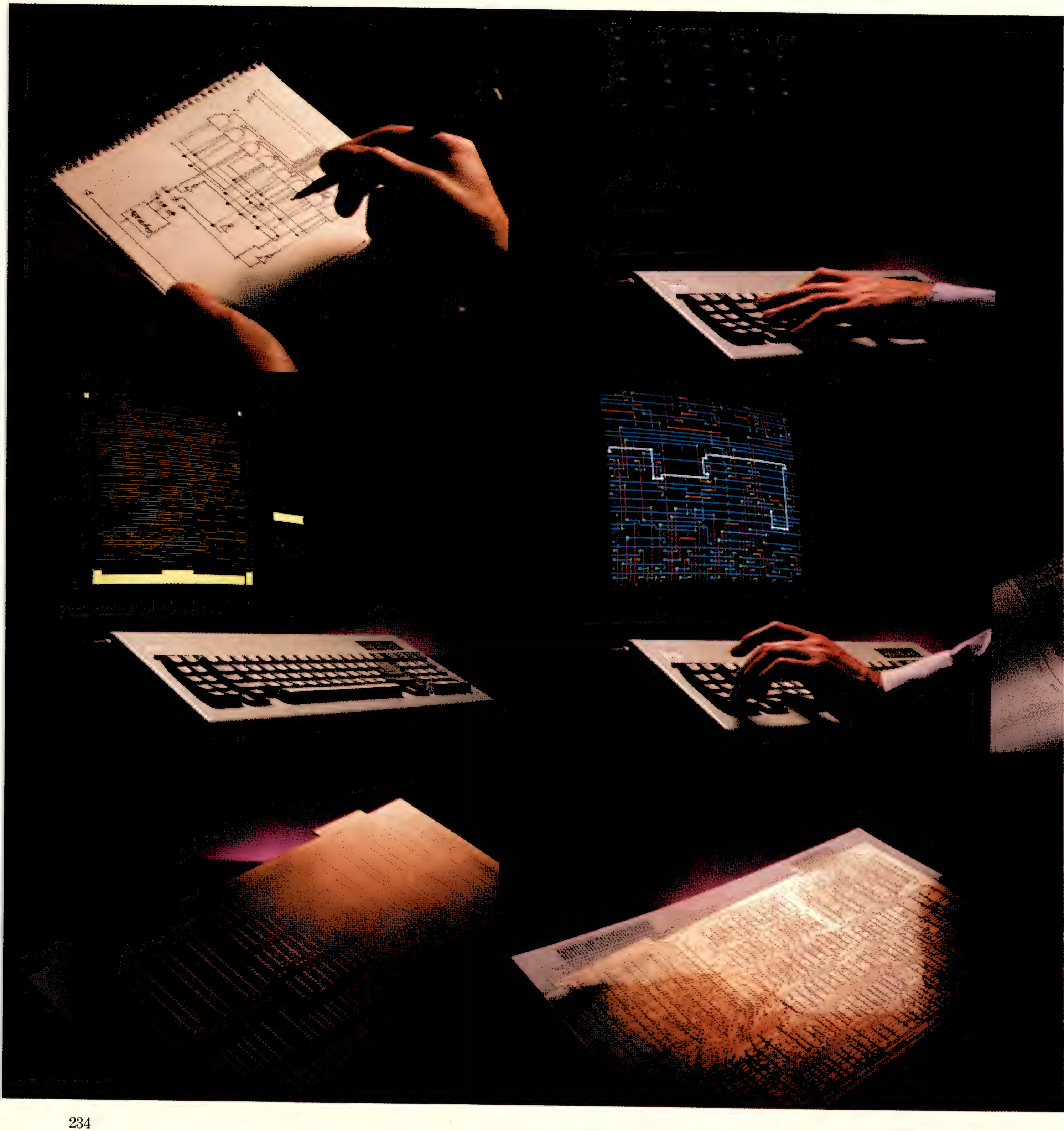
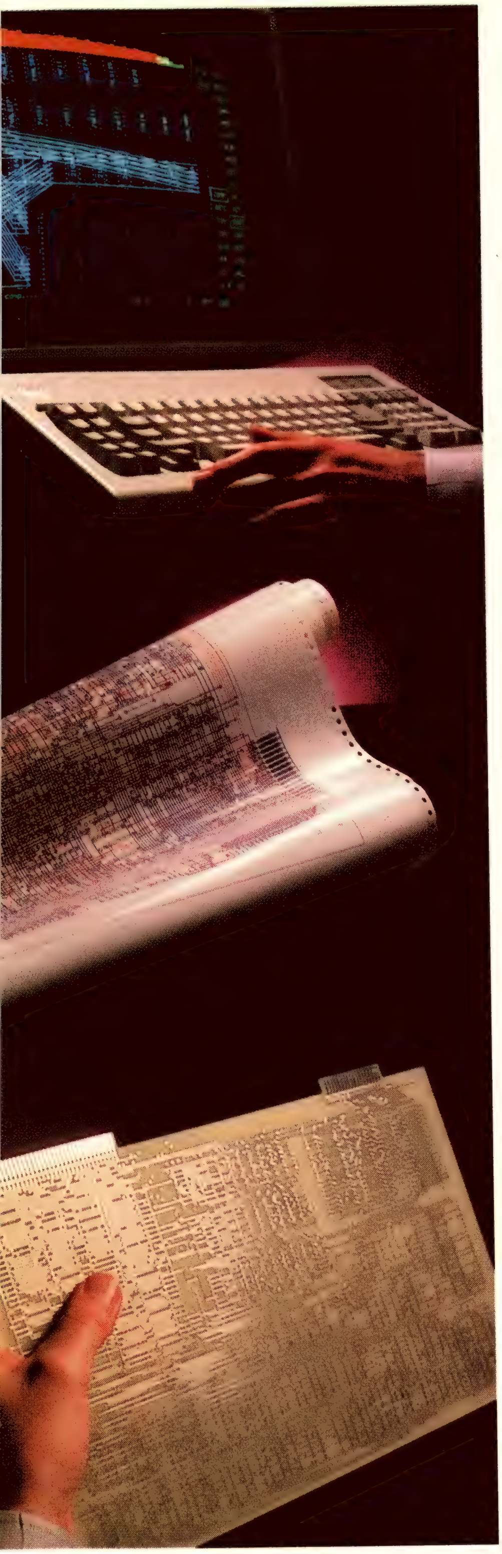


Fig 1—Unijunction transistor Q1 produces a pulse burst suitable for controlling an SCR. R1 controls the phase angle for firing the SCR.

Total integration. That's the benchmark.



P-CAD's newest generation CAE/CAD design tools can take you all the way from concept to finished design on one system. That's why it's the Benchmark against which other design automation products are being judged.



☐ FIRST, COMPARE FUNCTION.

P-CAD provides a true end-to-end PCB design solution. Designers can create preliminary sketches interactively with the PC-CAPS schematic capture program. Once the conceptual data is formalized, tools like PC-PLACE perform automatic component placement. A built-in histogram capability aids in part swapping to optimize placement. Next, PC-ROUTE provides automatic routing for trace interconnections.

After the plots have been run and artwork generated, PC-DRILL extracts the data needed to generate paper tapes. These tapes drive the NC-drilling machines so that prototypes and finished PC boards can be manufactured. With P-CAD, concept to prototype is all a single, totally integrated system.

☐ NEXT, COMPARE PRICE.

P-CAD's modular PCB design software runs on a standard PC-AT,™ or compatible computer. So you get the functionality of a high-priced workstation at a fraction of the cost. And without getting locked into a one-vendor hardware solution.

☐ THEN, COMPARE OUR FEATURES WITH EVERYONE ELSE.

Other CAE/CAD systems give you some of P-CAD's features. But no one has them all. Here are a few of the capabilities that make P-CAD the Benchmark in PCB design:

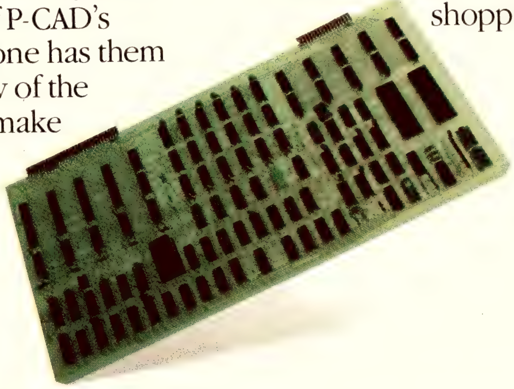
- All software runs under MS-DOS.™
- Supports many medium and high-resolution graphics boards.
- Single point data entry; once data is captured with PC-CAPS, user never needs to re-enter it.
- Boards can be designed on up to 25 layer pairs with PC-ROUTE.
- PC-ROUTE users can select from multiple routing strategies for the highest completion rates.
- User can stop and start PC-ROUTE at any time.
- PC-PLACE lets user define multiple placement lattices, provides tools for locating, analyzing, and optimizing the resulting placement, and handles both DIPs and discrete components.
- PC-DRILL can extract data from PC-CARDS design database for transferring data to paper tape punch machines, and provides optimization of drilling patterns.
- Support for pen plotters, dot matrix printers, and all models of photoplotters with PC-CARDS.

☐ NOW, COMPARE COMPANIES.

Setting the standard in PCB Design software is just one of our achievements at P-CAD. We're breaking ground in semi-custom IC and programmable logic device (PLD) design, too. By adding function. And reducing price.

Call P-CAD toll-free at (800) 523-5207 (in CA: 800-628-8748.) Or write: Personal CAD Systems Inc., 1290 Parkmoor Ave., San Jose, CA 95126. TELEX 3717199. (P-CAD products also available for rent or lease from US Instrument Rentals.)

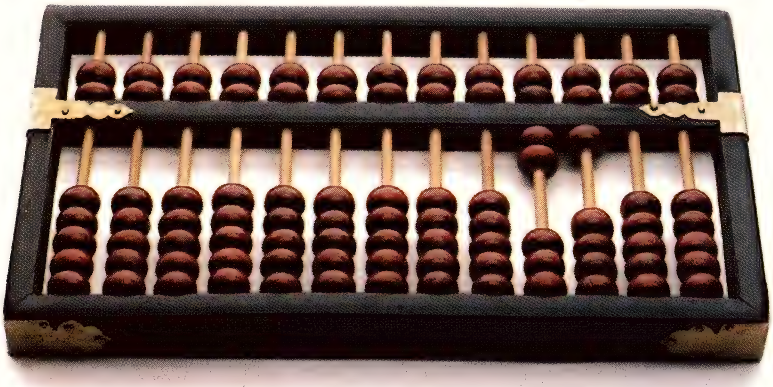
And do a little comparison shopping.



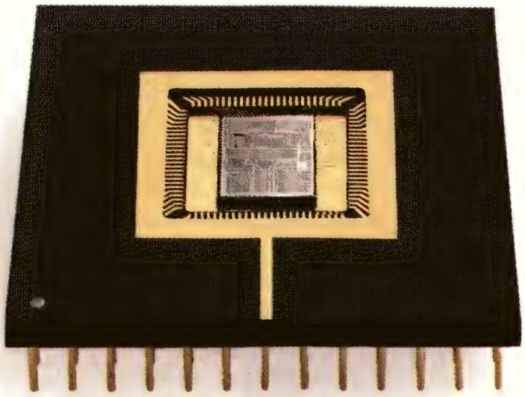
© 1986, Personal CAD Systems, Inc. IBM, PC, and AT are registered trademarks of International Business Machines Corp. MS-DOS is a trademark of Microsoft Corp.

p-cad™
THE BENCHMARK

CIRCLE NO 165



DIGITAL BY
ANALOGY.



DIGITAL BY ANALOG.

For DSP and numeric processing, your best source of digital is Analog, the industry's leading supplier of signal processing ICs.

Our number crunchers include a superior, high speed floating-point chip set. Along with the broadest line of fixed point multipliers and multiplier/accumulators.

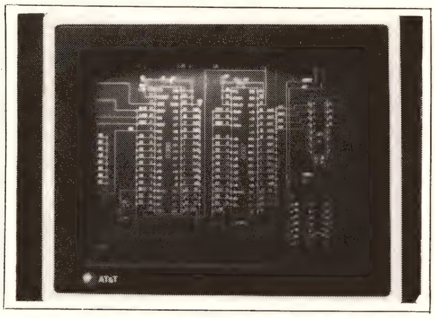
For microprogram sequencing and data address generation, Analog offers innovative Word-Slice™ devices – fast, functional and compact.

For a single-chip solution, we have the industry's highest-performance DSP processor. A powerful 8 MIPS machine, supported with first-class development tools.

Analog Devices – the pioneer of high-speed CMOS in DSP – manufactures these VLSI components in a 1.5µm CMOS process. So they're fast, cool, and reliable. And they are available now, with full support of MIL-STD 883B, Rev. C.

For more information, call your nearest Analog Devices, Inc. sales office. Analog Devices, Inc.: Austria (222) 885504; Belgium (3) 237 1672; Denmark (2) 845800; France (1) 4687-34-11; Holland (1620) 81500; Israel (052) 28995; Italy (2) 6883831 (2) 6883832 (3) 6883833; Japan (3) 263-6826; Sweden (8) 282740; Switzerland (22) 31 57 60; United Kingdom (01) 9410-466; West Germany (89) 570050.

ANALOG DEVICES



PC-BASED CAE/CAD

Three packages, Draftsman-EE, DC/Autorouter, and DC/Netlist, capture drawings, automatically route pc boards, and generate net lists, respectively. The programs run on IBM PCs and on the AT&T PC 6300. Using IBM's enhanced graphics adapter, the graphics editor can produce 16-color, 640×350-pixel resolution displays; using AT&T's high-resolution mode, displays spec 640×400-pixel resolutions. The design library features pins, wires, buses, and traces; the editor's capabilities include orthogonal rubberbanding. The autorouter package accepts boards that have as many as 16 layers and are as large as 32×32 in^2. A rat's nest display shows the origins and destinations of all interconnections. The autorouter creates output files for the drawing editor. You can use HP pen-plotters or Gerber Scientific photoplotters to produce final artwork. The net-list generation package creates a list for each schematic page; it includes common lines and bypass capacitors. Draftsman-EE, $749; DC/Autorouter, $2498; DC/Netlist, $295.

Design Computation Inc, 10 Frederick Ave, Neptune, NJ 07753. Phone (201) 922-4111.

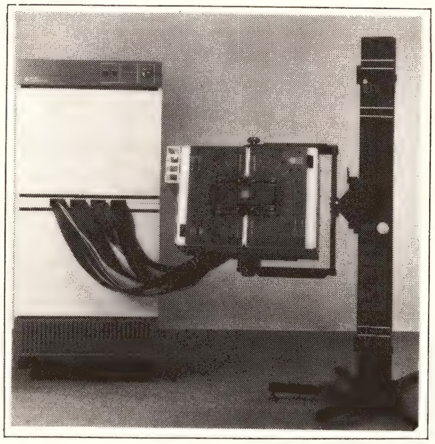
Circle No 351

CAE FOR MACINTOSH

Digital Macroscope, the second program in the Paragenesis Series of CAE software applications, simulates digital circuits at the gate and functional levels. You can perform three types of simulations: 12-state logical, physical, and parametric. The 12-state logical mode identifies true, false, strong, weak, conflicting, high-impedance, and undefined logic states. The physical mode uses source- and sink-current driving loads and input capacitances to measure rise and fall times of gate outputs. To the calculations of the physical mode, the parametric mode adds supply-voltage and -temperature variations, so this mode can monitor power consumption in a network. You can enter circuits into the program either by typing in a net list or by using the company's schematic editor. A simulation design language lets you describe logical blocks functionally; you can also select standard gates and MSI chips from the package's component library. The simulator requires either a Macintosh that includes 512k bytes of RAM and an external disk drive or a Macintosh Plus. Digital Macroscope (DM), $1000; schematic entry (SE), $700; DM and CE, $1500.

Advanced Engineering Solutions Inc, 75 Manhattan Dr, Boulder, CO 80303. Phone (303) 499-2910.

Circle No 352



ASIC TESTER

Using the 480 test channels of the Logic Master 2000 ASIC tester, you can functionally verify and characterize devices that have more than 300 pins. The instrument features dc parametric testing and a 100-psec timing-edge resolution. To verify a design, you can compare data acquired during a test with the results you found during a CAE logic-simulation run. The system includes programmable power supplies, interactive pattern editing, triggering, and, optionally, an automatic calibrator. Also included are a pattern generator that supplies input stimuli and a data-acquisition system that performs comparisons in real time. The system can resolve both pattern edges and data-acquisition sample times within 100 psec; pattern-generation output drivers and data-acquisition receivers spec 10-mV resolutions. The tester's Parametric Measurement Unit (PMU) provides a current-measurement resolution of 50 pA and a voltage-measurement resolution of 1.0 mV. You can use the unit to develop a parametric-test sequence; the unit can then automatically test every pin on a device. An integrated switchable matrix enables the PMU to address any pin on a device under program control. The switchable matrix can also disconnect drivers and receivers from the measurement path. $185,000 for a 256-channel system. Delivery scheduled for September.

Integrated Measurement Systems, 9525 SW Gemini Dr, Beaverton, OR 97005. Phone (503) 626-7117.

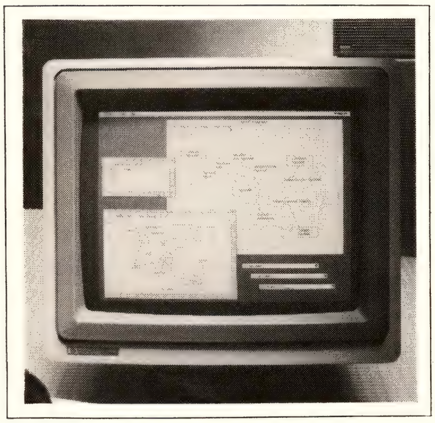
Circle No 353

EPLD DESIGN

The iState state-machine software package develops state-machine designs for erasable programmable-logic devices (EPLDs). The package offers a choice of design-description methods: It accepts multiple syntaxes for state definitions, specification of state transitions, inputs, and outputs. The EPLD-description package lets you mix state-machine and Boolean-equation descriptions; you can also use D-, JK-, set/reset-, and T-type flip-flops. Once this program has coded a state-machine design, you can enter the design into this company's PLD software package, which optimizes the logic code, determines the best choice of EPLD for the design, compiles the code, and produces a JEDEC or Intel hex file for programming. $500.

Intel Corp, Literature Dept W-298, 3065 Bowers Ave, Santa Clara, CA 95051. Phone local office.

Circle No 354



SOFTWARE DESIGN

Teamwork/Structured Analysis provides computer-aided support for the specification phase of software development. The software, which this company licenses from Cadre Technology (Providence, RI), runs on the 9000 Series 300 workstations. The program, which is a companion product for the 64000 logic-design system, uses the specifications it produces in conjunction with 64000 editors, cross compilers, and assemblers for μP-code development. A project library serves as a central database for all workers on a specific project. The library includes data dictionaries, data-flow diagrams, process specifications, annotations, and project-management data. The graphics editor enforces rules for building data-flow diagrams and specifies their relationships to other objects. Further, the editor can manipulate models and other system entries only in accordance with these rules. A consistency checker detects specification errors within and between data-flow diagrams, data-dictionary entries, and process specifications. A function that manages model configurations allows the collection of data-flow diagrams into sets. You can initiate analysis at any level in the set and then proceed either up or down the model set. In addition, an annotator can capture and store information that doesn't fit into the standard structured model, but which is necessary to your system model. $8500. Delivery, 12 weeks ARO.

Hewlett-Packard Co, 1820 Embarcadero Rd, Palo Alto, CA 94303. Phone local office.

Circle No 355

DESIGN MANAGER

This VAX-based package, the Sherpa Data Management System (DMS), automatically tracks and controls design projects and ensures that all users follow the correct design methodology. The package manages processes as well as data. To control design files, the system gives files encrypted names and assigns those names to a controlled directory. This directory maintains a record of the identity, origin, promotional level, authorized users, and history of each file. The software also keeps track of the relationship of each file to various projects so that engineers can share data. All file information resides in its own database; the management system doesn't affect the contents of each file. The package constructs and stores models of a project's procedures; whenever a user requests a file, the system consults the appropriate model and, if the request is legal, guides the user through the correct procedure. When the status of a file changes, the system ensures that access privileges also change. An alert feature notifies project staff of status changes, progress, and other user-defined events. $50,000 to $80,000.

Sherpa Corp, 2355 Old Oakland Rd, San Jose, CA 95131. Phone (408) 942-1535. TLX 703103.

Circle No 356

THE COMPLETE SOLUTION FOR MICROCODED PROCESSORS.

Analog Devices' ADSP-1401 and ADSP-1410 offer you the highest speed and the greatest functionality for key tasks in microcoded systems – microprogram sequencing and data address generation.

The ADSP-1401 MicroProgram Sequencer is the industry's most advanced IC for generating microcode addresses. It supplies 16-bit addresses with a clock-to-address delay of just 25ns. The chip supports 10 maskable, prioritized interrupts, as well as traps. A 64-word internal RAM is user-configurable for subroutine stack, register stack, and parameter storage. Four event counters streamline nested loops.

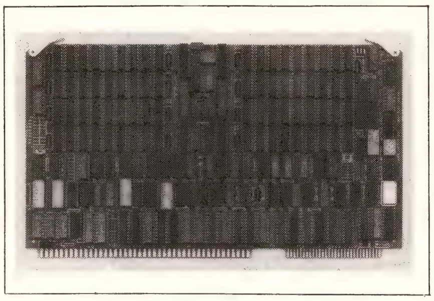
The ADSP-1410 is the industry's only IC dedicated to flexible, high-speed data address generation. It provides 16-bit pointers to data memory 30ns after the clock edge. Its thirty registers hold address pointers, offsets, comparison values, and initialization values. With its powerful zero-overhead looping structure, the device can – in a single cycle – output an address, modify it, and conditionally branch to an initialization address.

Both Word-Slice™ components offer low-power CMOS technology (≤375 mW) in a 48-pin ceramic or plastic DIP. And, microcode system development tools and support are available from many third parties, including Hewlett-Packard, Step Engineering, and HiLevel Technology.

For more details, call your nearest Analog Devices, Inc. Sales Office.

ANALOG DEVICES

CIRCLE NO 131

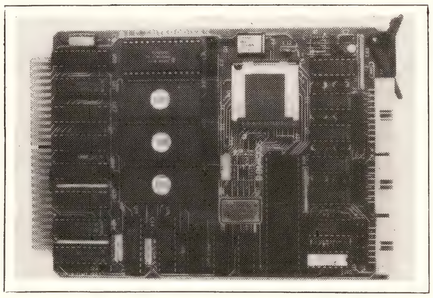


DYNAMIC-RAM BOARDS

Designed for Multibus systems, the LBX 512k- and 2M-byte dual-port dynamic-RAM boards offer LBX-bus read-data access rates of 195 nsec and 145 nsec, respectively. The 2M-byte version runs with no wait states asynchronously in systems with Intel's 6-MHz 286/10 and synchronously with Intel's 8-MHz 286/10A or 286/12 CPU. You can add either 64k- or 256k-byte RAMs to upgrade the memory capacity. Parity checking is standard. Four LEDs on top of the board indicate the results of a parity check. 512k-byte version, $890; 2M-byte version, $1150 (100).

Central Data Corp, 1602 Newton Dr, Champaign, IL 61821. Phone (800) 482-0315; in IL, (217) 359-8010. TWX 910-245-0787.

Circle No 357



SINGLE-BOARD µC

You can add an 80188 CPU to your STD Bus system by installing the SCC-188 single-board computer. You can also combine RAM, EPROM, or EEPROM for a maximum of 256k bytes of onboard memory and add as much as 1M byte of off-board memory. The board's 82530 chip provides two high-performance RS-232C and RS-422 serial-communication ports capable of asynchronous and synchronous communication modes, including Bisyn, HDLC, SDLC, and self-clocking modes. You use the DMA channel to achieve serial-communication rates of more than 1.2M bps. Additional onboard functions include a 58274 real-time calendar clock, interrupt controller, three 16-bit counter/timers, and a fully buffered STD Bus interface. The onboard memory, I/O mapping, and wait-state generation are software programmable. Options include a firmware monitor/debugger, PL/M, Fortran, Assembler, C, Pascal, and full symbolic debuggers. 5-MHz version, $549; 8-MHz version, $595.

RLC Enterprises, 1117 Hillview Dr, Milpitas, CA 95035. Phone (408) 946-7471.

Circle No 358

AT LAST! 500,000 DIRECT REPLACEMENTS PLUS 500,000 SUGGESTED REPLACEMENTS.

From over 400 electronic component manufacturers worldwide--The NEW Alternate Source and Replacement Series from D.A.T.A. is the most complete and up-to-date reference source available for locating solid-state electronic devices.

Designed for easy use by engineers, purchasing agents and others, this series can help you:

- Locate alternate sources to complete your design.
- Find replacements for unavailable parts.
- Search for replacement parts by generic types.

In four authoritative Guides, the complete series includes:

DISCRETE SEMICONDUCTORS
Replacement information on transistors, diodes, thyristors, optoelectronic and microwave devices.

Direct Replacement Guide identifies over 350,000 direct replacements from 352 manufacturers.

Suggested Replacement/ Alternate Source Guide identifies more than 470,000 suggested replacements from 92 manufacturers.

INTEGRATED CIRCUITS
Replacement information on digital, interface, microprocessor, audio/video, linear and memory ICs.

Direct & Suggested Replacement Guide identifies more than 150,000 direct and suggested replacements from 127 manufacturers.

Generic/Alternate Source Guide organized by generic family, identifies over 110,000 alternate sources from 289 manufacturers.

$105 EACH (U.S.)

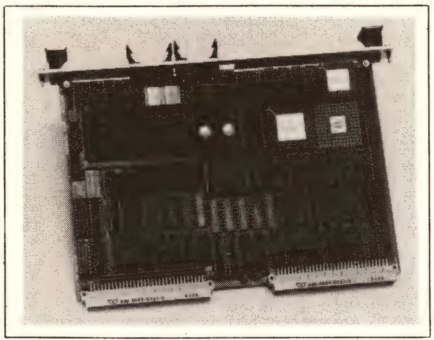
- Price includes two complete semiannual editions of each guide.

SPECIAL OFFER! Purchase any two guides together for $170 and save $40. There's never been a better time to find more direct and suggested replacement information than with this special introductory offer! To place your order or receive a **FREE** brochure on the Alternate Source and Replacement Series from D.A.T.A., call TOLL-FREE

1-800-854-7030
(In CA call 1-800-421-0159)

30-Day Money-Back Guarantee
Complete Series also available on magnetic tape.

D.A.T.A. INC. A Cordura Company
P.O. Box 26875, Dept. S0766, San Diego, CA 92126
In Canada: Call 416-238-0366
Outside U.S. and Canada: Telex (England) 95671



32-BIT μC

The HK68/V20 offers a 68020 μP (no wait states at 12.5 MHz); as much as 1M byte of onboard, dual-access dynamic RAM; as much as 128k bytes of EPROM; nonvolatile static ROM for user functions; and one RS-232C serial port (RS-422 optional). You can order the board equipped for a 24-MHz 68020. Other standards include a high-speed memory expansion bus, mailbox interrupts, and a master/slave interface to VME Bus with 32-bit data path and 32-bit addressing. Options include a 68861 page memory-management unit and an onboard 68881 floating-point coprocessor. Military versions are also available. This μC has a multilayer construction with GND and V_{CC} planes. Board size measures 9.19×6.3 in. Power requirements are 5V dc at 7.0A and ±12V dc at 0.5A. Operating systems that run on the μC include Unisoft, UniPlus+, Unix System 5.2-compatible operating system with Berkeley enhancements, and the VRTX real-time executive. With 1M-byte RAM, $3595; with 256k-byte RAM, $2895.

Heurikon Corp, 3201 Latham Dr, Madison, WI 53713. Phone (608) 271-8700.

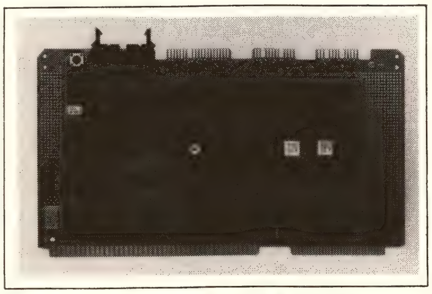
Circle No 359

DRIVE CONTROLLER

The SNC4030-PC controller board plugs into IBM PCs and compatible computers and controls two standard Winchester disk drives, two floppy-disk drives, and one QIC-02 streaming-tape drive. The board lets you overcome the DOS 32M-byte limit per disk. A diskette containing streaming-tape utilities allows you to back up and restore files, directories, or entire disks. This board contains the HDC9224 disk-controller IC, HDC9226 digital-data-separator IC, and the FDC765A floppy-disk-controller IC. In addition, it provides data-error detection and correction. $275 (99).

Standard Microsystems Corp, 35 Marcus Blvd, Hauppauge, NY 11788. Phone (516) 273-3100. TWX 510-227-8898.

Circle No 360



MOTOR CONTROLLER

The DMC-201, a single-axis digital motion controller, positions dc or brushless dc motors by using a variety of control modes such as point-to-point positioning, velocity profiling, and phase-locked speed control. It allows you to program the position, speed, acceleration, gain, and damping coefficients of the motors. The controller accepts commands in ASCII characters from a host computer, or motion commands can be entered and stored in nonvolatile memory for stand-alone operation. Conditional statements, which can test for status of I/O lines, completion of a motion, position, and elapsed time, let the controller make decisions based on program actions. The controller's editor allows you to enter, modify, and store programs. This controller implements digital compensation for stabilizing the motor. $665 (100).

Galil Motion Control Inc, 1928-A Old Middlefield Way, Mountain View, CA 94043. Phone (415) 964-6494. TLX 171409.

Circle No 361

FLOATING-POINT CHIP SET WITHOUT COMPROMISE.

Analog Devices' ADSP-3210/3220 floating-point multiplier and ALU are the industry's best available solution for fast IEEE arithmetic. This chip set provides blazing throughput and low latency – without compromise.

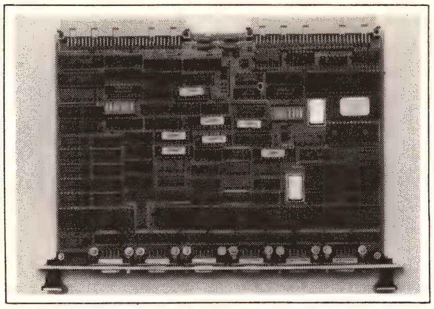
The chips execute an extensive set of operations on 32- and 64-bit IEEE floating-point and 32-bit fixed point. So, systems using them have the flexibility to support all standard data formats.

Circuit innovations and a fast 1.5μm process allow each chip to achieve 10 MFLOPS for most operations. And with CMOS, there are no power or reliability penalties.

What's more, number-crunching speed doesn't come from cumbersome pipelining. Because it has just one internal pipeline stage, the ADSP-3210/3220 is the industry's lowest-latency double precision chip set in production. And, with this architecture, microcode development is simple.

For more details, call your nearest Analog Devices, Inc. Sales Office.

ANALOG DEVICES

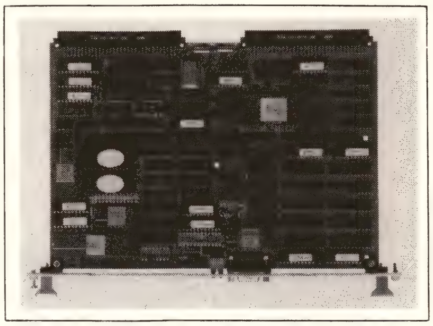


CONTROLLER BOARD

The VME Bus intelligent terminal controller (CD23/3608) board features eight programmable I/O channels that you can configure as asynchronous or synchronous RS-232C interfaces. You can also configure two of the interfaces independently for the RS-422/449. The board supports data rates as high as 38,400 baud; higher rates are possible with synchronous operation. As much as 64k bytes of dual-port RAM, 64k bytes of EPROM, and 8k bytes of static RAM are available to the board's 8-MHz 8088 μP. The standard driver available with the board includes self-diagnostic routines, parity error detection, and interface to Unix and other operating-system drivers. $720 (100).

Central Data Corp, 1602 Newton Dr, Champaign, IL 61821. Phone (800) 482-0315; in IL, (217) 359-8010. TWX 910-245-0787.

Circle No 362

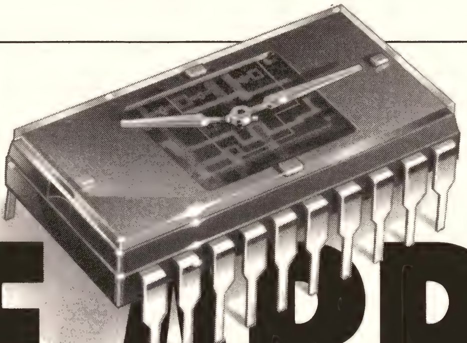


VME BUS CONTROLLER

Bringing graphics capability to the VME Bus, the VG-640 graphics controller combines the Hitachi ACRTC graphics controller with a 2D/3D command set executed by an onboard 32/16-bit CPU. This dual-height VME Bus board drives a 640×480- or 512×512-pixel noninterlaced display. It manipulates 8 bits/pixel, displaying 256 colors from a palette of 262,144. It draws as many as 35,000 vectors/sec. The onboard CPU-ACRTC enables character-drawing speeds of 5000 cps and raster operations of 1,200,000 pixels/sec. It can draw a complete screen in less than a second. Its high-level command set includes line, circle, ellipse, and polygon commands; fill commands; LUT (look-up table) commands; and text commands. The controller uses 4A typ at 5V dc. $2995.

Matrox Electronic Systems Ltd, 1055 St Regis Blvd, Dorval, Quebec, Canada H9P 2T4. Phone (800) 361-4903 (US only); (514) 685-2630. TLX 05822798.

Circle No 363



ONE DAY GATE ARRAYS. GUARANTEED.

Prototypes in 24 hours? Only from Laserpath, the gate array prototype specialists.

Lost time is the biggest risk in gate arrays. Now, we guarantee you'll know in one day—in silicon—if your design works. Because prototypes are the only way to know if your whole system works.

No worry about circuit changes, either. Revised prototypes are discounted and get the same one day turnaround.

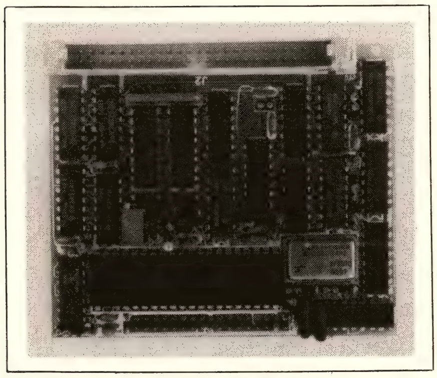
You'll design with industry standard 2μ and 3μ HCMOS families. Use extensive macrocell libraries supporting the leading CAD systems. And get volume shipments from our production, partners who are major IC manufacturers.

For details, call 408-773-8484 and ask for Earl Watts. Or write him at: Laserpath, 160 Sobrante Way, Sunnyvale, CA 94086.

Give us a day, and we'll save you weeks.

LASERPATH

ONE DAY GATE ARRAYS™

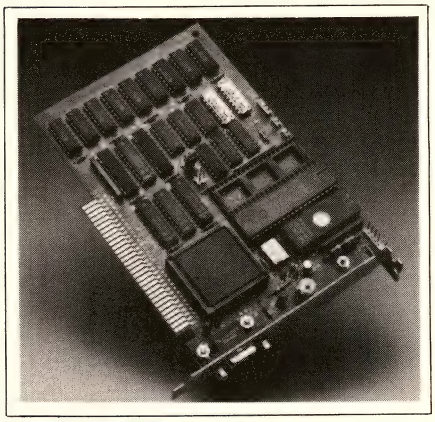


DISK CONTROLLER

The CBX-FDC, a single-wide, 8-bit SBX floppy-disk controller module, can control as many as four 5¼-in. or four 8-in. drives. Single-, double-, and quad-density 5¼-in. drives are supported, or you can use single- or double-density (FM/MFM) 8-in. formats. The module makes a connection to the drives via a 50-pin locking/jacking I/O connector. Because it is an SBX module, it can be driven either as a high-speed DMA device or as a system I/O device. It requires 0.9A of 5V for operation. $350.

Comark Corp, Box 474, Medfield, MA 02052. Phone (617) 359-8161. TLX 703156.

Circle No 364

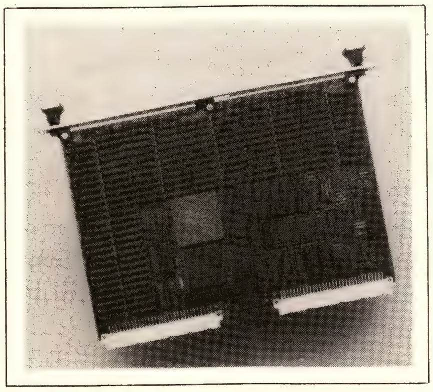


SINGLE-BOARD μC

This single-board IBM PC-compatible computer has the same dimensions as IBM PC expansion cards and plugs into a passive PC bus backplane. To fit on a 4.2×6.2-in. board, the CMOS Micro PC replaces 34 low-power Schottky chips and the entire Intel chip set (minus the 8088 μP) with one custom IC. All onboard ICs are CMOS, so current consumption (150 mA max) is one-third as high as the vendor's NMOS-based single-board computer. It contains an 8088 μP, a socket for an 8087 coprocessor, a keyboard port, 256k bytes of CMOS RAM, and the company's PC-compatible ROM BIOS. $550.

Faraday Electronics, 743 Pastoria Ave, Sunnyvale, CA 94086. Phone (408) 749-1900. TLX 706738.

Circle No 365

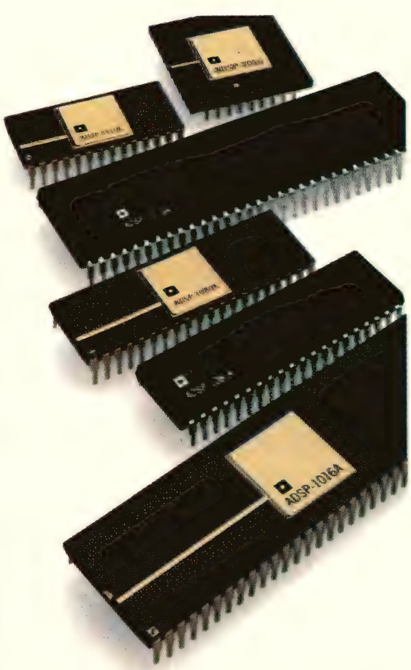


EDC MEMORY

The VME RAM is a 4M-byte memory with error detection and correction (EDC) for the VME Bus. It uses a custom EDC chip set and dynamic RAMs in zig-zag in-line packages with no daughter boards or cabling. Performance and price are comparable to parity memory as a result of the 64-bit-wide word used for error correction. The average access time can be as low as 180 nsec on read operations and 120 nsec on write operations. The VME RAM conforms to Revision C of the VME Bus specification, and supports sequential transfers and unaligned transfers. The VME RAM allows 16-, 24-, or 32-bit addressing and 8-, 16-, or 32-bit word lengths. $2895.

Clearpoint Inc, 99 South St, Hopkinton, MA 01748. Phone (800) 253-2778; in MA (617) 435-5395. TLX 298281.

Circle No 366



THE BROADEST LINE OF FIXED POINT MULTIPLIERS.

For systems now requiring fast fixed-point multipliers, Analog Devices has premier solutions. Our 8-, 12-, 16-, and 24-bit multipliers and multiplier/accumulators combine low power with high speed and performance.

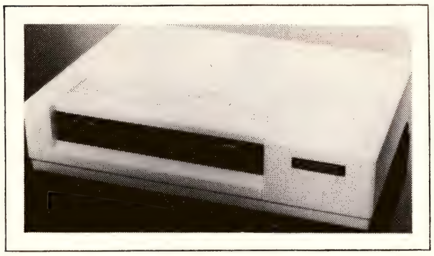
In 1982, Analog Devices was the first to offer CMOS alternatives to first-generation multi-watt bipolar multipliers. Today, our CMOS devices – with speeds of 10 to 30 MHz – continue to be the preferred alternatives in these sockets.

But we didn't stop there. We went on to design several innovative sub-100ns number crunchers. Like a 24 x 24 multiplier and a single-port 16 x 16 MAC in a low-cost 28-pin DIP. Both include many advanced features to simplify system design.

These DSP components – fabricated in our 1.5μm CMOS process – are offered in multiple packages, including pin-grid arrays, ceramic DIPs, and low-cost plastic DIPs. Ceramic parts are available processed to MIL-STD 883B, Rev. C, on Analog's MIL-M-38510-certified lines.

For more details, call your nearest Analog Devices, Inc. Sales Office.

ANALOG DEVICES

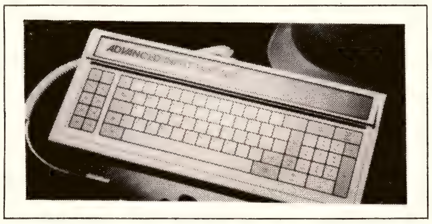


VIDEO PROCESSOR

Because it has a 64-color palette, the VP-210 video processor lets you transfer complex computer graphics from your monitor to your color printer or plotter. The unit incorporates firmware to simplify display transferrals. This video processor accepts RGB input directly from your terminal or personal computer and provides rasterized output for your printer or plotter. With its 60-MHz data rate and 18-msec horizontal line time, it can download your RGB input data in two to eight seconds, depending on screen resolution, to free your computer for other tasks. The unit is available with 1M or 2M bytes of RAM storage. Two switches let you make double-size printouts or repeat copies. 1M-byte version, $2995; 2M-byte version, $3495.

Graftel Inc, 400 Executive Blvd, Executive Park, Elmsford, NY 10523. Phone (914) 592-3700.

Circle No 367



SEALED KEYBOARD

For use with IBM PC and compatible computers, the Panelkey PKD-83 sealed keyboard withstands harsh environments. The unit operates in locations where heat, liquids, airborne contaminants, oil, and solvents make standard keyboards unreliable. The 83-key device incorporates a plastic overlay that provides embossed standard-legend keys. The key layout is identical to that of the IBM PC keyboard; the board generates the same codes. However, you can order the unit with features such as special electronics, custom overlays, and multilingual legends. The keyboard operates at temperatures ranging from 32 to 140°F. Delivery, stock to six weeks ARO. $100 (OEM).

Advanced Input Devices, W 250 AID Dr, Coeur d'Alene, ID 83814. Phone (208) 765-8000. TWX 510-776-0584.

Circle No 368

COLOR PLOTTER

You can use the SE-293 desktop plotter to make hard copies of your B-size graphics. The plotter can accommodate as many as eight fiber-

OASYS Tool Kit Update

8088 8086 80186 **80286**

OUR INTEL SOFTWARE TOOL KIT KEEPS ON GROWING ...

WIZARD C-8086

- Supports 8086/88/87/186/286
- Runs in native and cross modes
- Complete K&R C plus V7 & III extensions
- Built-in LINT facility
- Addressing Models: small, compact, medium, large, huge
- Over 250+ functions in Run-time Library
- In-line assembly supported
- Intel & Microsoft compatibility at source and object levels
- Written in C; easily ported
- Highly optimized: 25%-40% tighter code
- Compiles over 1,000 lines/min.; 2+ times faster than Lattice
- Generates ROMable code
- Ideal for embedded real-time system or PC application development
- Supports DOS 2.x and 3.x, IBM/BIOS

OTHER OASYS 8086 TOOLS

- Symbolic C Source Level Debuggers
- Intel compatible Macro Cross Assembler/Linker/Locator
- Overlay PC Linker
- 8086/186 Simulator
- 80+ function Floating Point Library
- C Profilers
- QA tools
- C Interpreter with Dynamic Linking Loader
- C Run-time Analyzers
- C Documentor/Formatters
- Up/down Line Communication Tools
- Full screen, multi-window Editors/WPs
- Unix-like Tools for PC
- Software design tools

AVAILABILITY

Native: PC/XT/AT, all PC look-alikes, and DS-32 PC Co-Processor running MS/DOS, PC/DOS, and Xenix.

Cross: VAX VMS/Unix, Pyramid, Sun, Masscomp, Apollo, dozens more.

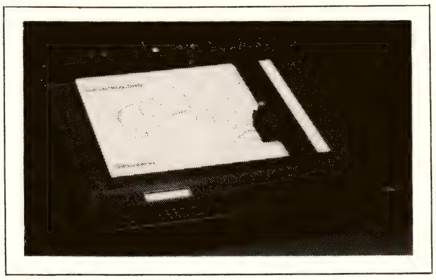
You name it . . .

OASYS provides a "One-Stop Shopping" service for more than 125 products running on, and/or targeting to, the most popular 32-, 16- and 8-bit micros and operating systems.

A DIVISION OF XEL Oasys

60 Aberdeen Avenue, Cambridge, MA 02138
(617) 491-4180

We Specialize In:
Cross/Native Compilers C, Pascal, Fortran, Cobol, Basic, APL, PL/1, Prolog, Lisp, ADA — Assemblers/Linkers — Symbolic Debuggers — Simulators — Interpreters — Translators Converters — Profilers — QA Tools — Design Tools — Comm. Tools OS Kernels — Editors — Spreadsheets — Data Bases — VAX & PC Attached Processors and more
We Support:
680xx, 80x86, 320xx, 68xx, 80xx, dozens more



tip, ballpoint, or drafting pens. An electrostatic hold-down feature lets you use paper that is smaller than 11×17 in., and the unit's chart advance and paper cutter provide automatic operation for larger page formats. An optical positioning system allows the SE-293 to operate at 4-ips with 0.01-in. resolution. You can plug this plotter into your computer via an RS-232C or GPIB port. The plotter includes a keyboard for entering parameters such as application pressure, acceleration, and writing speed; an LCD displays your parameter selections. $3495.

BBC-Metrawatt/Goerz, 2150 W 6th Ave, Broomfield, CO 80020. Phone (800) 821-6327; in CO, (303) 469-5231. TLX 4970869.

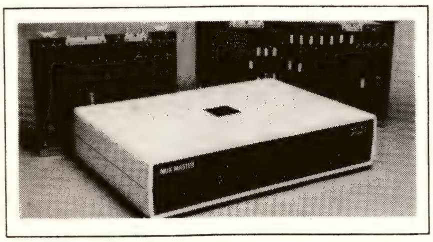
Circle No 369

TOUCH SCREEN

The TouchMonitor 14, a 14-in. monochrome monitor, tilts and swivels and is IBM compatible. You can order it with either a green or an amber screen. Resolution is 256×256 on an IBM PC or PC/XT and 670×670 on a PC/AT. The monitor runs with either 110 or 230V power supply. The touch screen uses transparent membrane switches with a glass protective backing. Response time is 5 msec. You can add an antiglare screen made of nylon mesh. $398 (OEM).

Personal Touch Corp, 4320-290 Stevens Creek Blvd, San Jose, CA 95129. Phone (408) 246-8822.

Circle No 370



MULTIPLEXER

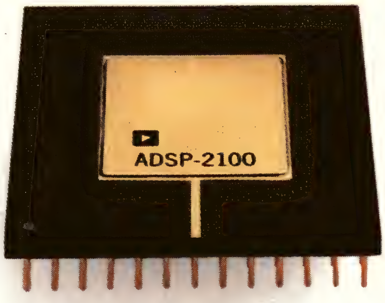
The Muxmaster provides a terminal networking system between a MicroVAX II, VAX, or PDP-11 computer and related terminals. By using one CPU board, you can connect as many as 128 channels to a single Q-Bus- or UniBus-based computer. Each cluster's controller communicates with eight or 16 users at asynchronous data rates between 50 and 38,400 bps. The host board connects 16 cluster controllers that communicate at 1M bps. The unit uses twisted-pair cable, allowing you to place a terminal as far as 2000 ft away from the host computer. It provides full-data error correction and is software compatible with VMS, MicroVMS, RSX, and RSTS. From $3000.

Able Computer, 3080 Airway Ave, Costa Mesa, CA 92626. Phone (714) 979-7030.

Circle No 371

GRAPHICS DISPLAY

The Viking 1 is a high-resolution graphics display system for your IBM PC or compatible computer. It features a 19-in. monochrome monitor that has a 1280×960-pixel resolution, which the controller refreshes at 66 Hz. The Viking 1 also includes a 1024×2048-bit video memory with font/format storage area, a DMA controller for high-speed data exchange with the PC



BREAKTHROUGH PERFORMANCE FROM A DSP MICROPROCESSOR.

Analog Devices' ADSP-2100 is the first single-chip DSP microprocessor to break the bit-slice performance barrier. Now, for the first time, high-performance and ease-of-design are combined in a single CMOS DSP solution.

For calculation-intensive algorithms, the 2100 features three independent computational units: a 16-bit ALU, a 16 x 16 multiplier with a 40-bit accumulator and a robust barrel shifter. To keep the numbers coming, the 8 MIPS processor has unmatched program sequencing and data address generation capabilities.

The ADSP-2100's architecture allows two operands to be fetched from off-chip in parallel with on-chip computation. With this efficient use of external memory (up to 48K) you'll avoid the I/O bottlenecks typical of other processors.

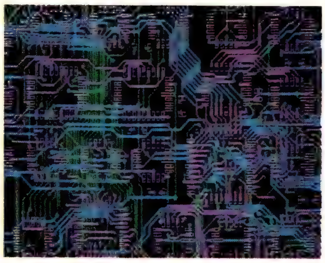
Extensive ADSP-2100 support streamlines your development schedule. The processor is programmed in a high-level algebraic assembly language. Development tools include extensive software support and a full-speed emulator.

Whether your application is modems, speech, imaging, graphics, radar, sonar, or control, the ADSP-2100 gives you outstanding performance, while speeding your project to completion.

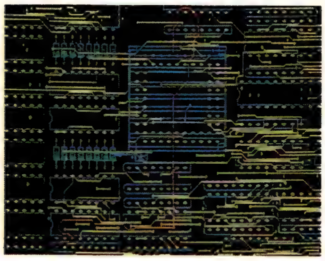
For more details, call your nearest Analog Devices, Inc. Sales Office.

ANALOG DEVICES

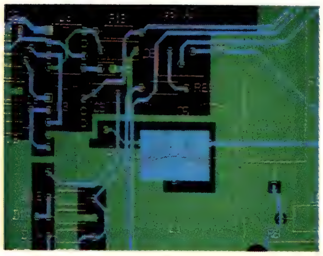
TELESIS GIVES YOU MORE THAN ONE PATH TO THE FUTURE.



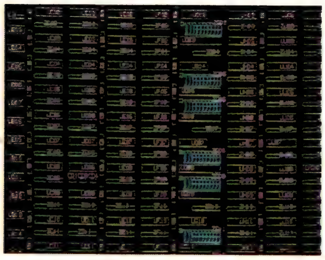
SMD TOOLBOX
For surface-mounted and thick-film hybrid designs.



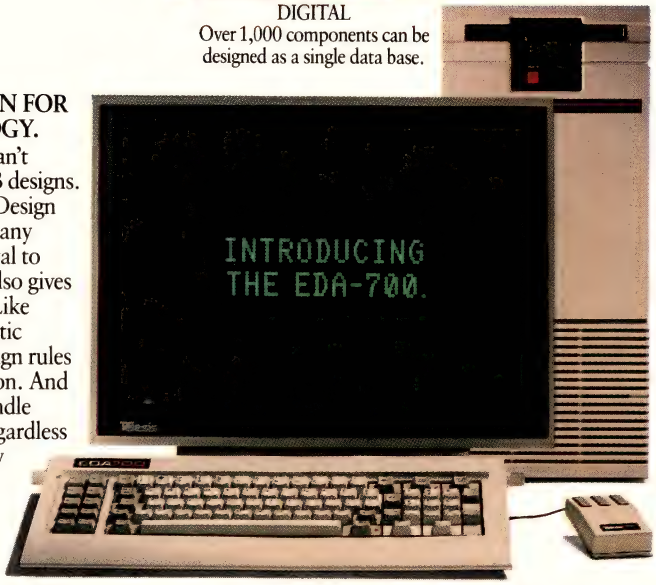
ECL TOOLBOX
Automates design of transmission lines.



ANALOG
Automatically handles non-uniform characteristics.



DIGITAL
Over 1,000 components can be designed as a single data base.



THE CAD WORKSTATION FOR EVERY PCB TECHNOLOGY.

Most CAD systems just can't handle today's complex PCB designs.

But the Telesis EDA-700 Design Workstation lets you follow any technology path—from digital to analog to ECL to SMD. It also gives you complete design tools. Like schematic creation. Automatic placement and routing. Design rules checking. Artwork generation. And it's so flexible it can even handle tomorrow's PCB designs, regardless of device technology, density or packaging technique.

Telesis takes you beyond conventional design solutions. Our unique Thermal Analyzer software predicts thermal behavior prior to prototyping. And our fully integrated Design Capture System places low-cost productivity tools in the hands of the engineer.

With all this capability at an affordable price, it's no wonder that Telesis ships more PCB CAD workstations than anyone else in the U.S.

For complete information, call us at 617-256-2300. Or write Telesis, Two Omni Way, Chelmsford, MA 01824. We'll put you on the path to the future of PCB design.

Telesis

CIRCLE NO 138

bus, and a hardware character generator. The system works with standard PC monitor interfaces. $2195.

Moniterm Corp, 5740 Green Circle Dr, Minnetonka, MN 55343. Phone (612) 935-4151.

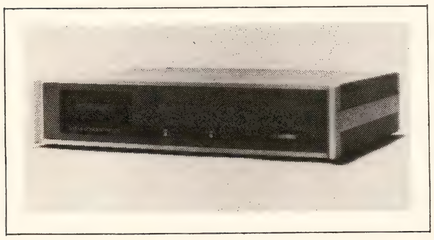
Circle No 372

TRACKBALL

Designed for use with the IBM PC family, the Lynx trackball simplifies cursor control. The device attaches to the serial port of a PC. The trackball comes with a graphics driver diskette, a manual, a cable, and a plug-in power supply. You can transfer a trackball command file to your hard-disk drive for automatic execution upon start-up. The Lynx doesn't require a special or level surface for proper operation. $159.

Disc Instruments, 102 E Baker St, Costa Mesa, CA 92626. Phone (714) 979-5300.

Circle No 373



CONCENTRATOR

Suitable for use in a bar-code data-collection system, the Model 9161A-02 multidrop concentrator manages bidirectional data traffic between a host computer and as many as 140 bar-code readers and printers. You can use four of the concentrator's 16 channels to support multiple bar-code devices. The remaining 12 channels provide point-to-point connections for additional devices. The unit comes with 64k bytes of RAM and a 20k-byte data buffer. A switch-configurable hardware interface and user-selectable protocols make the 9161A-02 compatible with most computers. An internal NiCd battery protects your data and parameter settings in the event of a power failure. $3950.

Intermec Corp, Box 360602, Lynnwood, WA 98046. Phone (206) 348-2600. TLX 152447.

Circle No 374

$975

EE DESIGNER™

CAE/CAD Integrated Software Package

At only $975, no electrical engineer can afford to be without this end-to-end circuit design, simulation and PCB layout tool. EE Designer has all the benefits a design professional expects in a high performance CAE/CAD system, without the high cost.

Order your EE Designer package today. Visionics offers an unconditional money-back guarantee. If you're not satisfied, return the system in 30 days and we'll refund your money in full.

PRODUCT HIGHLIGHTS

Schematic Capture
☐ Interactive schematic drawing
☐ Netlist generation
☐ Parts packaging
☐ Symbol libraries

Circuit Simulation
☐ Logic simulation
☐ Waveform timing analysis
☐ Interactive operation
☐ Stability check

PCB Layout
☐ Multilayer capability
☐ Ratsnest function
☐ Rubber-banding
☐ Auto design rule check
☐ Comprehensive component library

Postprocessing
☐ Output for pen plotters, printers, photoplotters, N/C drill tape

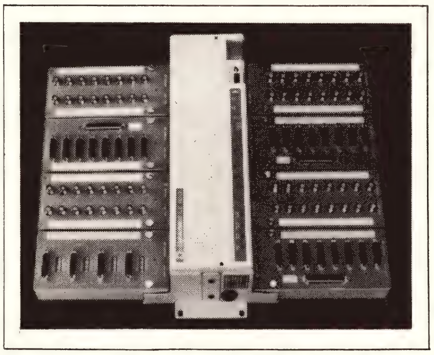
SYSTEM REQUIREMENTS
☐ IBM PC, XT or AT with 512K memory
☐ IBM color or Tecmar hi-res color graphics
☐ Mouse System, MS or Logi mouse
☐ Houston Hi Pad digitizer or Hitachi Tiger Tablet
☐ Calcomp, Houston, HP or Hitachi plotters
☐ Gerber compatible photoplotter
☐ Epson compatible printer

To order, call 1-800-225-5669
...or write:

VISIONICS
CORPORATION
1284 Geneva Drive
Sunnyvale, CA 94089

IBM PC, XT and AT are trademarks of International Business Machines Corp.

CIRCLE NO 154



RS-232C CHANNEL UNIT

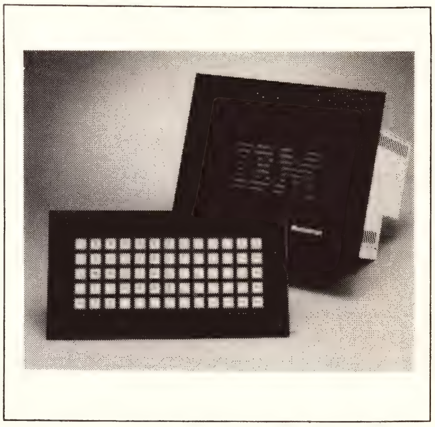
The RS-232-AF is a fiber-optic channel unit that operates with this company's LC-100 fiber-optic data multiplexer. The channel unit supports a variety of RS-232C communciation schemes, including binary synchronous and SDLC, at transmission speeds reaching 19.2k bps. It features four general-purpose RS-232C ports, DCE and DTE interface configurations, and modem control. You can configure each port independently and switch-select independent internal, external, or looped clock timings. Each LC-100 system accepts as many as eight RS-232-AF channel units. $775.

Lightcom Inc, Box 57045, Hayward, CA 94545. Phone (415) 786-1200.

Circle No 375

DISPLAY PACKAGE

The MON-1501 RGB color monitor and the KBD-2202 keyboard are suitable for use in harsh environments. The MON-1501 has a 12-in. screen that is protected by a nonglare Lexan window. Displaying text or graphics in any of eight foreground or background colors, the CRT has a TTL interface and connects directly to an IBM or compatible color-graphics monitor card. The display has a 15.75-kHz sweep rate and a resolution of 640×200 pixels in its graphics mode. In text mode, the CRT displays 25 lines of 80 characters each. The KBD-2202 keyboard is sealed to comply with NEMA 4/NEMA 12 requirements. You can mount it in a rack, on a wall, or on a table top. Its 35-key membrane includes an upper- and lowercase alphabet, a 10-key numeric pad, and 10 function keys. MON-1501, $1290; KBD-2202, $450.



Nematron Corp, Box 1108, Ann Arbor, MI 48106. Phone (313) 426-5445.

Circle No 376

THE PERFECT UNION FOR REAL-TIME DEVELOPMENT

Heurikon's LINK/X™ Real-Time Development System makes your real-time headaches a thing of the past. LINK/X provides bi-directional communication between UNIX™ and multiple processors running under the Hunter and Ready VRTX® real-time executive. LINK/X lets you develop code under UNIX, download to VRTX, test and debug—all over the system bus or serial link!

With LINK/X you will never need to compromise on performance again. Using Heurikon's powerful MC68010 or MC68020, Multibus™ or VME microcomputer board families, systems can be configured to meet the most demanding application requirements. Customized versions can include up to 16 VRTX processors with a host of peripherals.

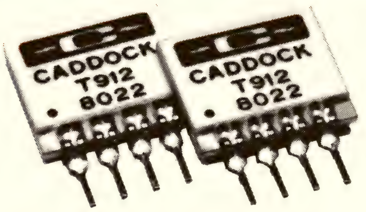
Cure your real-time development headaches now! Call Heurikon at **1-800-356-9602 (ext. 397)** and ask for LINK/X. Heurikon Corporation, 3201 Latham Drive, Madison WI 53713.

LINK/X is a trademark of Heurikon Corporation.
UNIX is a trademark of Bell Laboratories, Inc.
VRTX is a registered trademark of Hunter and Ready.
Multibus is a trademark of Intel Corp.

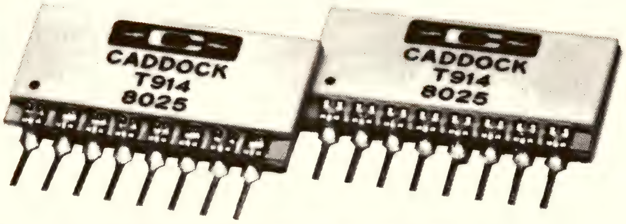
HEURIKON CORP

CIRCLE NO 139

Type T912 / T914 Ultra-Precision Resistor Networks from CADDOCK provide Ratio TCs to 2 PPM/°C and Ratio Tolerances to ±0.01% for precision analog designs.



Type T912 Ultra-Precision Resistor Network 'Pairs'



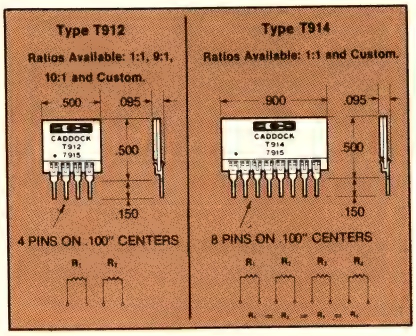
Type T914 Ultra-Precision Resistor Network 'Quads'

Type T912 / T914 Ultra-Precision Resistor Networks are constructed with Caddock's Tetrinox™ resistance films to achieve all of these high performance characteristics:

- **Absolute Tolerance:** 0.1% for all resistors.
- **Ratio Tolerances:** From ±0.1% to ±0.01%.
- **Ratio Temperature Coefficients:** From 10 PPM/°C to 2 PPM/°C.
- **Absolute Temperature Coefficient:** ±25 PPM/°C from 0°C to +70°C, referenced to +25°C.
- **Ratio Stability of Resistance at Full Load for 2000 Hours:** Within ±0.01%.
- **Shelf Life Stability of Ratio for Six Months:** Within ±0.005%.

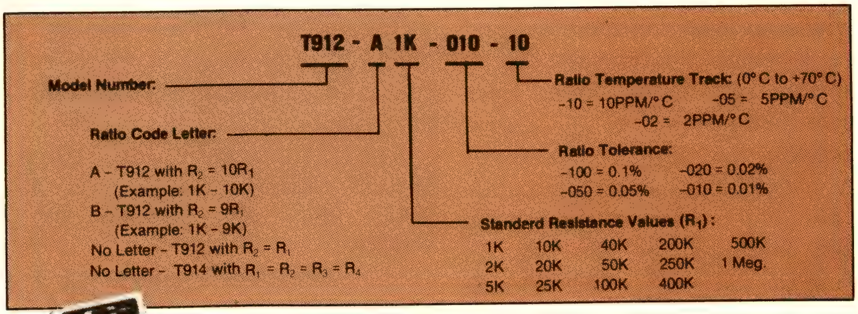
This exceptional combination of performance specifications - and the compact, plug-in configuration of the Type T912/T914 precision resistor 'pairs' and 'quads' - provide the single-package matched resistor characteristics and stability required by high-accuracy analog circuits, including -

- **Precision analog amplifiers.**
- **Voltage reference circuits.**
- **Instrumentation bridge circuits.**
- **Voltage and current comparison circuits.**



Standard models of Type T912 / T914 precision resistor 'pairs' and 'quads' include 14 off-the-shelf resistor values with a wide choice of Ratio Tolerances, Ratio TCs and Resistance Ratios:

This standard part number provides a selection of over 500 in-production models of Type T912/T914 precision resistor 'pairs' and 'quads':



T912 - A 1K - 010 - 10

Model Number:

Ratio Code Letter:

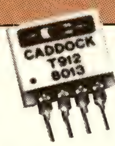
A - T912 with $R_2 = 10R_1$
(Example: 1K - 10K)
B - T912 with $R_2 = 9R_1$
(Example: 1K - 9K)
No Letter - T912 with $R_2 = R_1$
No Letter - T914 with $R_1 = R_2 = R_3 = R_4$

Ratio Temperature Track: (0°C to +70°C)
-10 = 10PPM/°C
-05 = 5PPM/°C
-02 = 2PPM/°C

Ratio Tolerance:
-100 = 0.1%
-020 = 0.02%
-050 = 0.05%
-010 = 0.01%

Standard Resistance Values (R_1):

1K	10K	40K	200K	500K
2K	20K	50K	250K	1 Meg.
5K	25K	100K	400K	

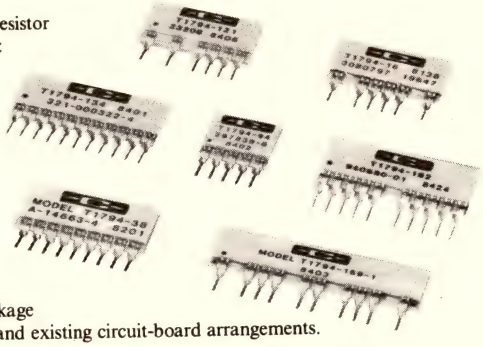


As an example of the price/performance advantages of this advanced resistor technology, the Model T912-A1K-010-10 shown here provides a 1K-10K resistor 'pair' with a ratio tolerance of ±0.01% and a ratio temperature coefficient of 10 PPM/°C at a 1000-lot unit price under $2.66. The same resistor 'pair' with a ratio tolerance of ±0.1% delivers at a 1000-lot unit price under $1.52!

Type T1794 Custom Precision Resistor Networks meet special circuit and packaging requirements:

The Type T1794 custom precision resistor networks provide a unique range of flexibility:

- From 2 to 15 resistors per assembly.
- Absolute tolerances from 1.0% to 0.05%.
- Custom voltage and power ratings.
- Resistance values from 500 ohms to 10 Megohms
- Absolute TC from 50 PPM/°C to 25 PPM/°C.
- Ratio TC from 50 PPM/°C to 5 PPM/°C.
- Variations in pin configurations and package size as required to meet performance and existing circuit-board arrangements.



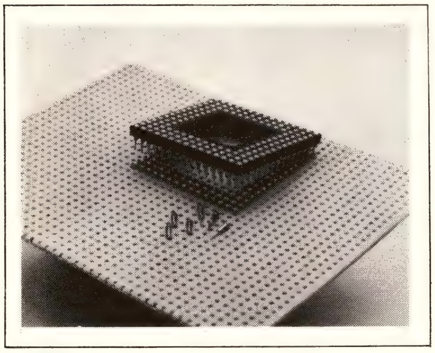
Caddock's advanced film resistor technology is the source of these outstanding advantages—advantages that are matched by a 20-year record of outstanding 'in-circuit' reliability.

Discover how easily these problem-solving resistors can improve the performance and reliability of your equipment, too. For your copy of the latest edition of the Caddock 24 page General Catalog, and specific technical data on any of the more than 150 models of the 13 standard types of Caddock High Performance Film Resistors and Precision Resistor Networks, just call or write to -

Caddock Electronics, Inc., 1717 Chicago Avenue, Riverside, California 92507 • Phone (714) 788-1700 • TWX: 910-332-6108

CADDOCK
HIGH PERFORMANCE FILM RESISTORS

CIRCLE NO 140

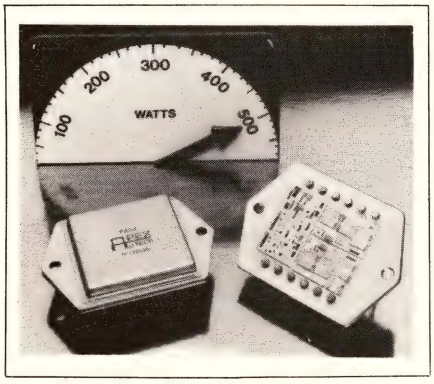


PIN CARRIERS

Series 512/514 PGA pin carriers are rigid and stable for efficient pin placement. They feature removable socket pins that incorporate a beryllium copper 6-finger contact that provides an insertion force averaging 2.5 oz/pin. The contact design uniformly distributes force. Each carrier features 45° funnel entry. Precision-machine brass sleeves prevent wicking and contamination by flux and solder. Standard pin plating is 30 μin. of gold with tin plating on the sleeve. Other available platings are 16 μin. of gold on the contact with tin on the sleeve or tin plating on both the contact and sleeve. Carrier for 68 pins with standard plating, $5.08 (100).

IEE Inc, 7740 Lemona Ave, Van Nuys, CA 91405. Phone (818) 787-0311. TWX 910-495-1707.

Circle No 377

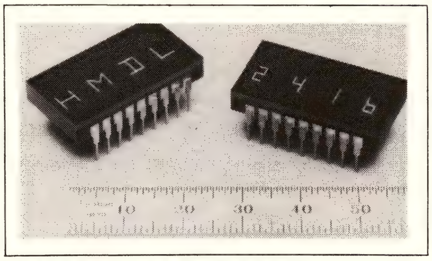


POWER OP AMP

The PA03 hybrid power op amp can deliver output currents as high as 30A or voltages to 70V. Internal power dissipation is rated at 500W max. It features dynamic current limiting that self-adjusts to load and heat-sinking conditions; two heat sensors located on top of the power transistor chips provide minimal thermal gradients and fast reaction time, according to the manufacturer. A thermistor controls the operating point to ensure stability over the temperature range. Precision thick-film current resistors eliminate the need for low-ohm external resistors. The device also features externally adjusted balance control separated from high current supply and a common-collector output design that reduces losses and internal heat generation. The front end is laser trimmed, which results in a voltage offset of 0.5 mV max and a drift figure of 10 μV/°C. Bias current is 10 pA max. $190 (100). Delivery, stock to eight weeks ARO.

Apex Microtechnology Corp, 5980 N Shannon Rd, Tucson, AZ 85741. Phone (602) 742-8600. TLX 170631.

Circle No 378

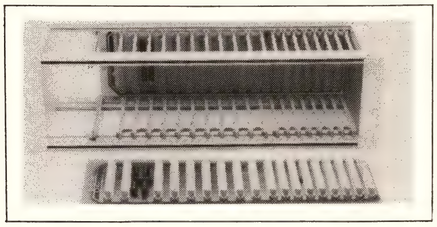


SMART DISPLAYS

The HMDL-2416 is a 0.15-in., red GaAsP display for 4-character, 16-segment readouts. Operating range is −55 to +100°C. The TTL-compatible display features an access time of 160 nsec. It includes an ASCII decoder, memory, multiplexing circuitry, and LED driver. Built-in diodes provide protection from electrostatic discharge. The displays stack end to end and provide an off-axis viewing angle of 65°. Two high-reliability screening versions are available. The HMDL-2416 TXVB program conforms with Level A test tables of MIL-D-87157 for hermetically sealed LED displays with qualification and 100% screening. The HMDL-2416 TXV program is a modification of Level A of MIL-D-87157 with 100% screening only. $104.35 (100); TXVB, $173.55 (10); TXV, $151.55 (10).

Hewlett-Packard Co, 1820 Embarcadero Rd, Palo Alto, CA 94303. Phone local office.

Circle No 379



CARD CAGE

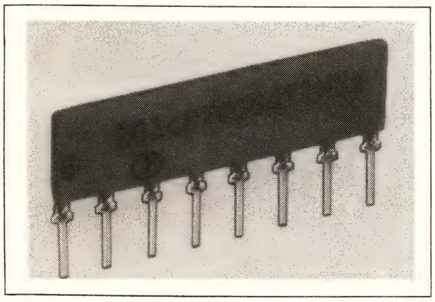
The RM65-7018E card cage accepts as many as 16 RM 65 μC modules plus a power supply; it fits in a standard 19-in. rack. Fabricated of extruded aluminum, it has a backplane, 16 slots for RM 65 modules, two connectors, and a terminal block for a power supply. Eight slots are on standard 0.6-in. centers, and eight are on extended 0.8-in. centers. The card cage is designed to accept the company's RM65-7600NE power supply, which furnishes 5V, ±12V, and ±15V. This supply allows a system to mix modules, such as a floppy-disk controller requiring 12V and analog modules requiring ±15V. Complete card cage, $350; mother board only, $90; power supply, $225.

Dynatem Inc, 19 Thomas, Irvine, CA 92718. Phone (714) 855-3235. TWX 910-595-2603.

Circle No 380

CAPACITOR NETWORKS

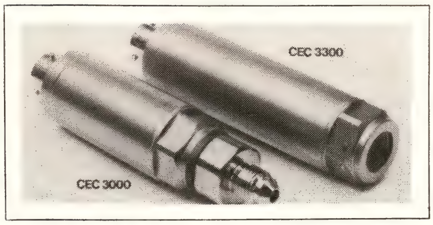
The Series 201 capacitor networks come in 8- and 10-pin single-in-line packages. EIA characteristic X7R and C0G ceramic capacitors are standard. Circuits include multiple isolated capacitors and multiple capacitors with common ground. Options include 4- to 22-pin package configurations, mixed capacitor values, and custom circuit designs.



Standard values range from 10 pF to 0.1 μF; capacitance tolerances of ±10% and ±20% are available. Operating range is −55 to +125°C. Operating voltage is 100V max at 85°C and 50V max at 125°C. Packages feature 0.1-in. pin spacings; the maximum seated height is 0.3-in. An 8-pin network, with seven 470-pF (C0G) capacitors and ±10% capacitative tolerance, $1.40 (5000).

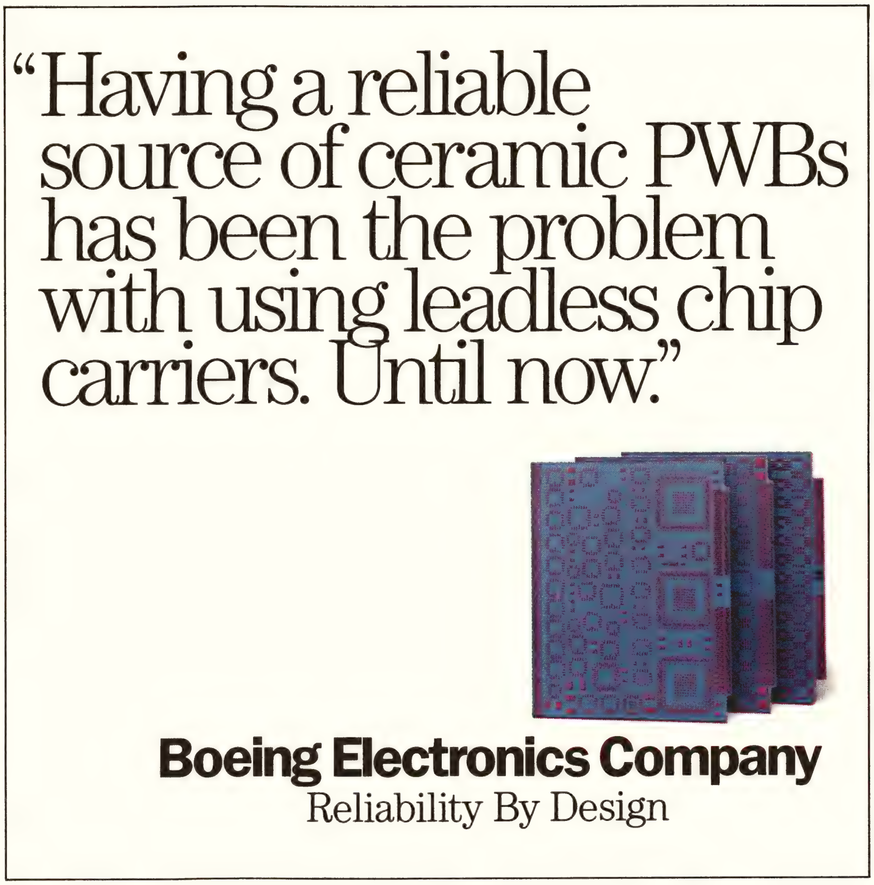
Sprague Electric Co, Box 9102, Mansfield, MA 02048. Phone (617) 339-8900.

Circle No 381

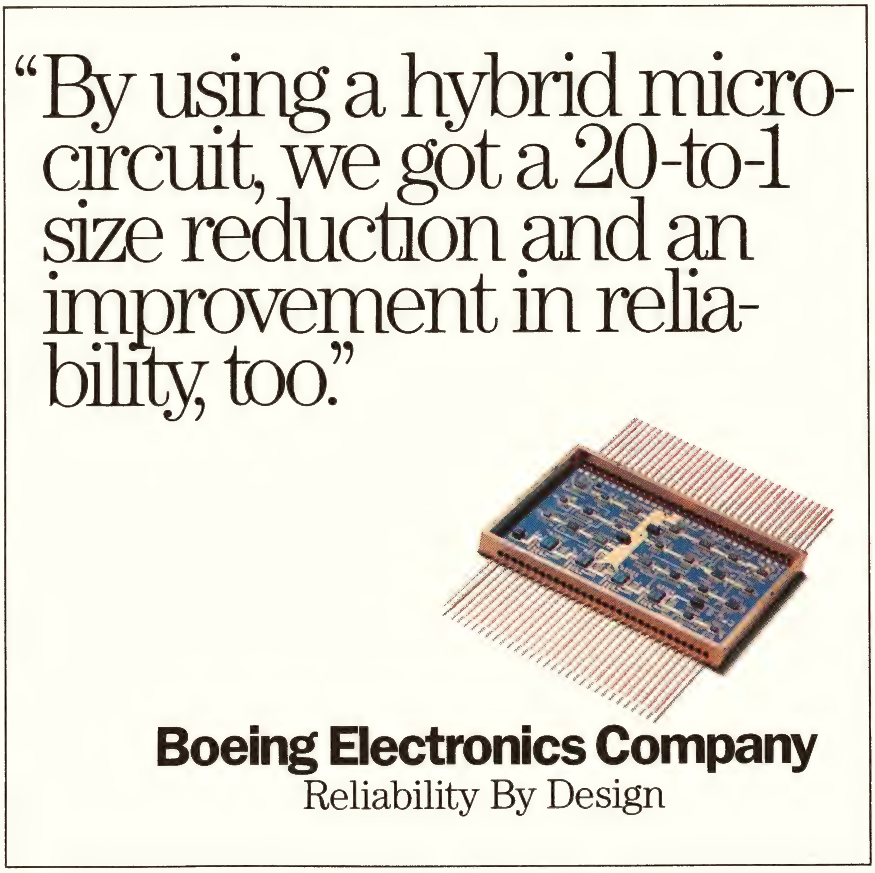


TRANSDUCERS

The 3000 and 3300 pressure transducers are available in pressure ranges from 0 to 15 through 0 to 6000 psi. The transducers operate over a −65 to +300°F range and are compensated from −65 to +250°F. The devices can withstand as much as a 100g shock without damage. Because the gauge attachment method does not use epoxy or other bonding agents, gauges follow precisely the pressure fluctuations that produce strain in the pressure-summing diaphragm. Maximum combined nonlinearity-hysteresis nonrepeatability for the 3000 is ±0.22% full-range output. Long-term drift is reduced to <0.1% from 10 minutes after turn-on at zero applied pressure. Thermal zero and sensi-


"Having a reliable source of ceramic PWBs has been the problem with using leadless chip carriers. Until now."

Boeing Electronics Company
Reliability By Design

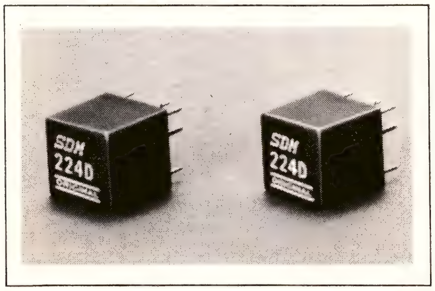

"By using a hybrid microcircuit, we got a 20-to-1 size reduction and an improvement in reliability, too."

Boeing Electronics Company
Reliability By Design

tivity shift is 0.008%/°F. The 3300 features a 5V, 2-mA output, direct or isolated. In addition, it provides misconnection and input-transient protection; zero stability is 0.1% max. From $500.

Transamerica Delaval, CEC Instruments Div, 325 Halstead St, Pasadena, CA 91109. Phone (800) 368-3812.

Circle No 382



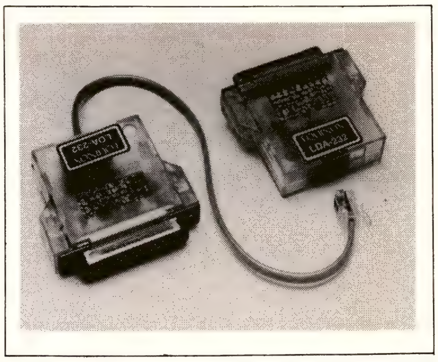
RELAY

Sealed to facilitate pc-board cleaning, the SDM relay measures 0.39×0.37×0.39 in. for dense packaging requirements. Operating time is 3 msec; contact rating is 1A at 120V ac or 24V dc, and coil voltage ratings range from 3 through 24V dc. Life expectancy is more than 100 million operations. Available in 1 form C or 2 form C latching type contact configurations, the relay features bifurcated crossbar contacts of silver palladium with a gold plate. $1.93 (1000). Delivery, 8 to 12 weeks ARO.

Original Electric Mfg Co Inc, 123 B Lincoln Blvd, Middlesex, NJ 08846. Phone (201) 271-5770.

Circle No 383

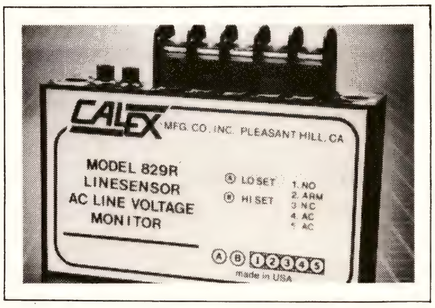
TERMINAL ADAPTER



The LDA-232 adapter allows any RS-232C computer terminal to transmit asynchronous data more than three miles at speeds to 19,000 bps. It eliminates weak signals and unpredictable data transmission caused by long in-house wiring runs. Full-duplex data can travel distances that exceed RS-232C cable limits. The adapter is fully transparent to data. You can pair these adapters to link terminals and computer ports, or a single line driver can connect a remote terminal to one of the company's PBXs to provide keyboard-controlled port sharing and switching. All connections use twisted-pair cable. An RJ11 modular telephone jack connects the adapter to the cable. $70.

Equinox Systems Inc, 12041 SW 144 St, Miami, FL 33186. Phone (800) 328-2729; in FL, (305) 255-3500. TLX 153893.

Circle No 384

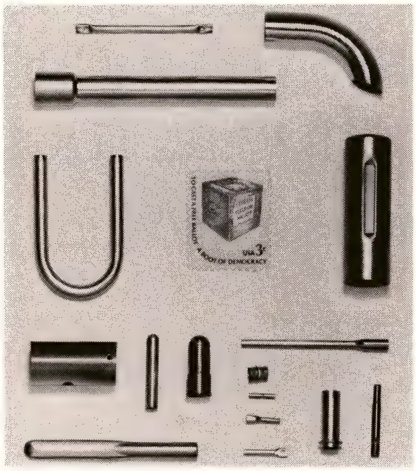


VOLTAGE MONITOR

The Model 829R Linesensor can respond to ac-line drop-out in <20 msec. While monitoring the line for catastrophic outages, the device also averages the ac line and continuously checks for average high- and low-voltage conditions. Accuracy in averaging is >0.5V ac in <100 msec. You can adjust the high and low trip points via molded-in potentiometers. You can set them to trip when the line voltage varies any amount from ±5 to ±20% from normal line voltage. The output of the device is a set of relay contacts.

tube • ability

t(y)üb-ə-'bil-ət-ē **1.** the capacity of small tubing to be formed and fabricated in multiple shapes to extremely close tolerances. **2.** formation of small to miniature parts with diameters as small as 0.003″ O.D. and 0.002″ I.D. **3.** automatic low cost production of miniature parts with part-to-part uniformity on specialized machinery built by Uniform Tubes.



Define your problem . . . we'll build your solution.
Send for illustrated design information.

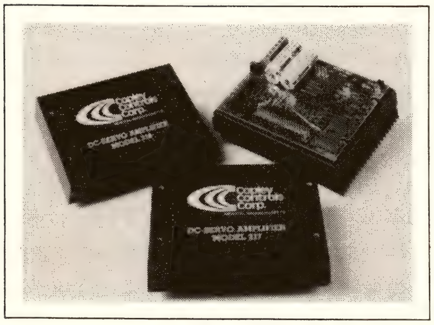
UTI
UNIFORM TUBES, INC.
Collegeville, PA 19426-0992 • Telephone: 215/539-0700
TWX: 510-660-6107 • Telex: 84-6428

CIRCLE NO 143

When the line voltage is within the high and low set voltages, the spdt contacts become energized. The contacts can handle 1A at 26V dc or 0.5A at 115V ac (both noninductive). Trip-point stability is ±0.03%/°C; isolation from the ac line is 2500V dc. The unit has molded through holes for mounting and a barrier strip for easy wiring. $116.

Calex Mfg Co Inc, 3355 Vincent Rd, Pleasant Hill, CA 94523. Phone (415) 932-3911. TLX 338506.

Circle No 385



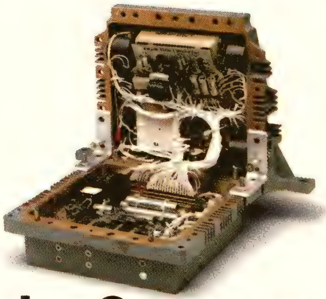
SERVO AMPLIFIER

The Model 217 wideband 4-quadrant PWM servo amplifier provides 2.1-kW peak power (±14A, ±150V) for two minutes and delivers 750W continuous. The PWM design and MOSFET-bridge output circuit hold heat dissipation at full load to 12W. Full-load efficiency is 98%. The amplifier is protected against short circuit, overload, and excessive temperature rise, and needs no derating to 70° when mounted on a machined base plate. The amplifier operates at a PWM switching frequency of 22 kHz. This switching rate eliminates the acoustic noise associated with low-frequency designs. It operates on unregulated supplies in the 50 to 150V range, has an internal dc/dc converter for generation of circuit bias voltages, and drives servo motors rated as low as 50V. $435 (100). Delivery, four to six weeks ARO.

Copley Controls Corp, 375 Elliot St, Newton, MA 02164. Phone (617) 965-2410.

Circle No 418

"With all the sophisticated electronics we're putting up in space, we aren't going to gamble on a power supply."



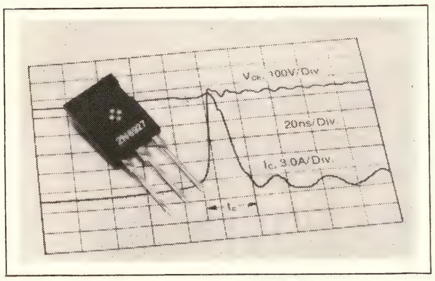
Boeing Electronics Company
Reliability By Design

EDN62686

"I want to find out more about Boeing's capabilities." You can depend on us for everything from hybrid microcircuits to custom power supplies, ceramic boards and more. For more information about what we can do for you, fill out this coupon and mail to: Boeing Electronics Company, P.O. Box 3707, M/S 9A-10, Seattle, WA 98124. Or call Karla Stensland at (206) 575-5755.

☐ Custom-design power supplies
☐ Ceramic circuit boards
☐ Hybrid microcircuits
☐ Other ____________

Name ____________
Firm ____________ Position ____________
Address ____________
City ____________ State ____ Zip ____________

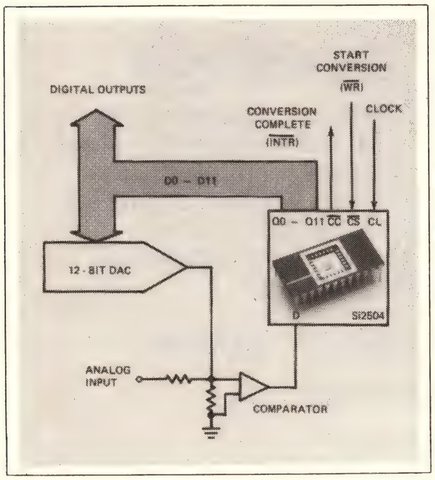


TRANSISTORS

The 2N6926 and 2N6927 bipolar npn switching transistors feature 35-nsec crossover time, V_{CEO}s of 400V and 450V respectively, 15A operating current, and guaranteed switching specs at 100°C. The inductive reverse-biased safe operating area allows the units to switch loads as high as 30A at 500V. The devices' rise and fall times are 32 and 30 nsec, respectively; storage time is 900 nsec. The transistors operate over −40 to +150°C. In a TO-247 plastic package, 2N6926, $5.75; 2N6927, $6.80 (100).

General Semiconductor Industries Inc, Box 3078, Tempe, AZ 85281. TWX 910-950-1942. Phone (602) 968-3101.

Circle No 386

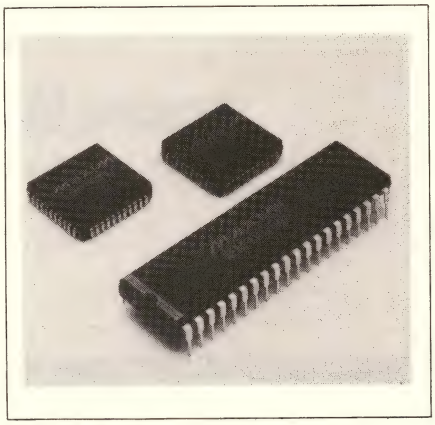


ADC REGISTER

The Si25HC04, a 12-bit successive-approximation register, is functionally compatible to the industry-standard bipolar 2504, but does not have its heavy power-supply current drain. The device is specified for clock frequencies as high as 10 MHz (15 MHz typ), and power-supply current is 3 mA. It includes an enable control that allows you to cascade devices for applications that require more than 12-bit resolution. Also included is a 3-state enable control to disable the outputs and put them into a high-impedance state. Housed in a plastic package, the device operates over 0 to 70°C; in ceramic, it operates over −55 to +125°C. In plastic DIPs, $6.61 (100).

Siliconix, 2201 Laurelwood Rd, Santa Clara, CA 95054. Phone (408) 988-8000. TWX 910-338-0227.

Circle No 387

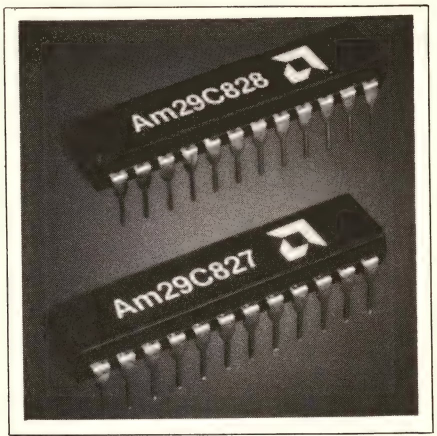


UP/DOWN COUNTERS

Models MM74C945 and MM74C947 are 4-digit up/down counters with onboard direct LCD drivers. The devices count inputs of 3 MHz and include a Schmitt trigger for counting signals with slow rise and fall times. Enable, store, and reset inputs allow the devices to function as frequency counters; a carry output allows synchronous cascading of counters without spurious carries. The 74C947 includes zero-blanking circuitry; the 74C945 includes circuitry to select display of the counter or latches and an input, which blanks the display. On both devices, connecting the oscillator pin to ground allows you to slave the display to an external backplane. In 40-pin plastic DIP, $7.50 (100).

Maxim Integrated Products, 510 N Pastoria Ave, Sunnyvale, CA 94086. Phone (408) 737-7600.

Circle No 388



INTERFACE ICs

Models Am29C827/828 CMOS bus buffers reduce power consumption by more than 80% over their bipolar counterparts. The two ICs have 10-bit data paths. Their 24-mA drive makes them suitable for mid-board applications. The devices feature 8-nsec propagation delay. The Am29C828 has inverting outputs, while the AM29C827 offers noninverting outputs. Versions in plastic leaded chip carriers and small-outline packages should be available in the third and fourth quarters of this year, respectively. In 24-pin plastic and ceramic DIP, $2.55 (100).

Advanced Micro Devices Inc, Box 3453, Sunnyvale, CA 94088. Phone (408) 732-2400.

Circle No 389

ECL RAM

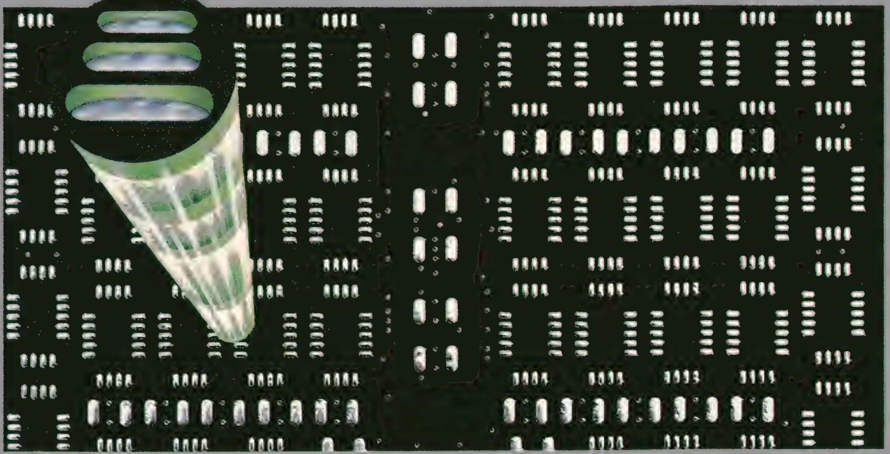
The 24-pin DM10422A-7 1024-bit ECL RAM specs worst-case access time of 7 nsec; the IC is configured as a 256×4-bit device with an optional 512×2- or 1024×1-bit configuration through externally accessible block-select controls. The device is intended for scratch-pad memory, buffers, and writable control-storage applications. The device is compatible with 10K and 10KH ECL logic. In a 24-pin ceramic DIP, $13 (100).

National Semiconductor Corp, Box 58090, Santa Clara, CA 95052. Phone (408) 721-5540. TWX 910-339-9240.

Circle No 390

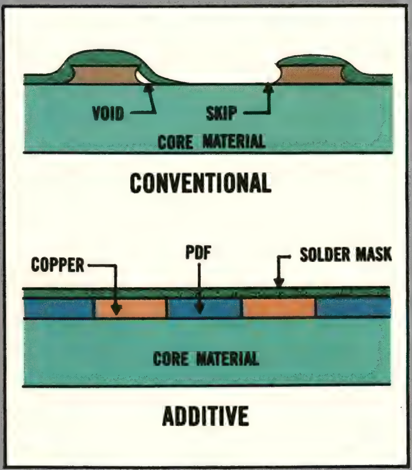
TAKE A CLOSER LOOK AT ADDITIVE'S SURFACE MOUNT CIRCUITS

The advantages of additive Surface Mount Circuits save time and money for users, give higher first-pass yields and totally predictable results. Here's why:



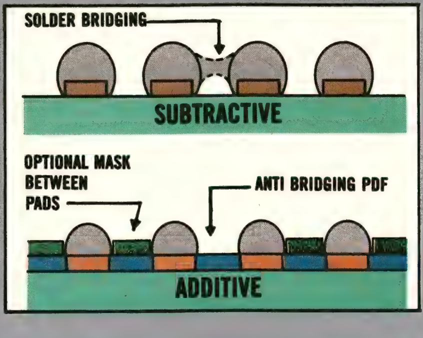
Better basic construction

The dielectric used to define lines/spaces (down to 0.003 inches) totally encapsulates conductor and pad sidewalls, and provides a near-flush surface for trouble free component mounting and soldering. Ideal for *all* surface mount devices from simple chip passives to "super-high" pin count PLCC's and Quads, and all common surface mount assembly, repair and cleaning processes. Hi-rel micro-vias, (0.010″ diameter min.), allow routing density beyond conventional capabilities.



SMOBC with Micro-socket™ option

A near-flush conductor surface allows uniform and precisely registered permanent *S*older *M*ask *O*ver *B*are *C*opper without skips, smear, bleed, or adhesion loss, simplifies glue and/or solder paste application. A Micro-socket™ soldermask option eliminates pad to pad bridging (even on 0.020″ pitch, leaded chip carriers) even when more solder is applied to avoid "missed" joints and improve reliability.



Trouble-free component repair

Unlike pad and trace "lifting" problems of conventional etched circuitry, Additive's new Micro-bond™ SMT surface allows soldering iron rework without adhesion failure.

IN A NUTSHELL, ADDITIVE SMC's GIVE YOU:

- The highest density circuitry available (down to 0.003″).
- Totally predictable geometries and electrical properties.
- Near-flush surfaces for trouble-free device placement.
- Pad side wall encapsulation equivalent to a perfectly registered soldermask for bridgeless soldering.
- Optional Micro-socket™ soldermask for hi-rel solder joints even on super-high pin count devices.
- Micro-bond™ pad and trace adhesion to "open-up" the repairability process window.
- Optional copper or soldercoated pads.
- The highest "first-pass" yield opportunity in assembly.

Send for complete information on SMC's or any Additive product.

EVERY ADDITIVE PRODUCT IS A PLUS FOR YOU

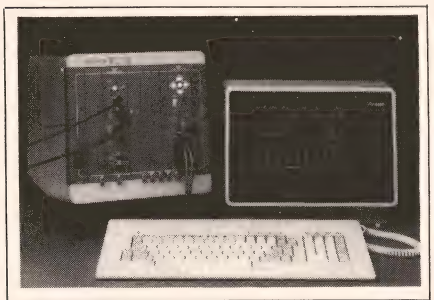
ADDITIVE PRODUCTS DIVISION
KOLLMORGEN CORPORATION
P.O. Box 700 Aquebogue, NY 11931

Please send me detailed information on:
☐ Additive PDF (High Density) Circuits–Tech Sheet #1
☐ Additive CPF (Precious Metal Replacement) Circuits–Tech Sheet #2
☐ Additive SMC (Surface Mount) Circuits—Tech Sheet #3
☐ Additive ALC (Add-A-Layer Multilayer) Circuits–Tech Sheet #4

EDN626

NAME
(Job Title)
COMPANY
ADDRESS
CITY STATE ZIP

CIRCLE NO 144

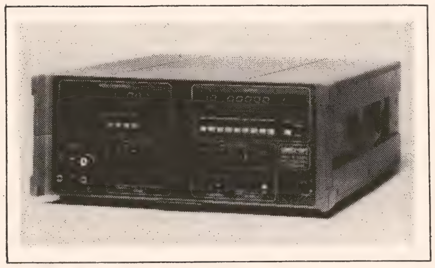


FAST DIGITIZER

The Model 6880 waveform recorder digitizes and records high-speed signals and waveforms at 1.3G samples/sec. You can operate the instrument in a stand-alone benchtop or system configuration and plug as many as six digitizers in one mainframe. A/D conversion takes place in 742 psec with 8-bit resolution on signals having bandwidths from dc to 250 MHz. The instrument has a 10,000-sample/channel memory. The digitizer is fully programmable via IEEE-488 or RS-232C. Model 6010 Magic Controller, required for systems operation, provides auto calibration, composite-video display, hardcopy outputs, and automatic or manual control. Model 6880, $15,500; Model 6010, $3950. Delivery, 30 days ARO.

LeCroy, 700 S Main St, Spring Valley, NY 10977. Phone (914) 578-6038. TWX 710-577-2832.

Circle No 391

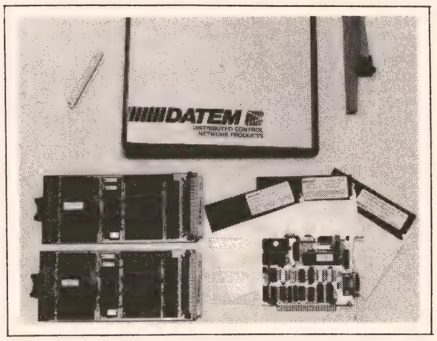


DMM CALIBRATOR

The Model 4700 multifunction DMM calibrator handles 6½-digit voltmeters and multimeters. You can use the device as a stand-alone bench instrument or in an IEEE-488-controller-based ATE system. The instrument supplies dc voltage of 10 nV to 1100V and ac voltage of 100 nV to 1100V (10 Hz to 1 MHz). DC current is 0.1 nA to 2A; ac current is 0.1 nA to 2A. Model 4700, including dc and ac voltage to 300W, IEEE compatability, and an autocalibration feature, $9995.

Datron Instruments, 4125 SW Martin Highway, Stuart, FL 33497. Phone (800) 327-0938.

Circle No 392



BITBUS DEVELOPER

The dDCM-Kit/Q Bitbus development system includes the dDCM802, a Q-Bus to Bitbus adapter, as well as Micro/RSX software support and dDCM870 and dDCM331 ladder-logic packages for industrial control. The hardware/software package provides an interface between Micro/RSX application code and a Bitbus system running Intel's iDCX-51 real-time operating system. The dDCM870 provides an IBM PC-based editor for preparing control programs using industry-standard ladder-logic symbols. This graphically represented program may be then transferred to the companion dDCM331 module, which provides a real-time ladder-logic interpreter operating under the iDCX51 operating system. dDCM870, $1275; dDCM331, $932.

Datem Ltd, 148 Colonnade Rd, Nepean, Ontario, Canada K2E 7R4. Phone (613) 225-5919. TLX 0533864.

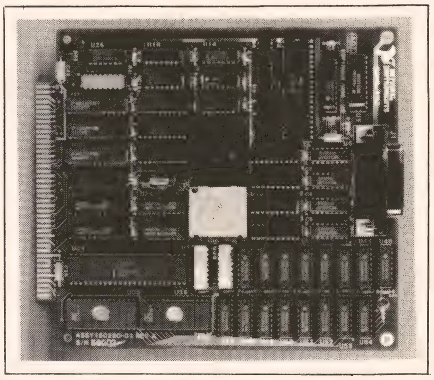
Circle No 393

ULTRIX COMPILERS

You can program in C for the 68000/010/020 family and 8086/186/286 family of μPs on the VAX and MicroVAX II computers running the Ultrix operating system. The compilers feature interrupt handling, I/O instructions, separate compilation, and recursive programming. BSO/C for the Motorola 68000/010/020 and Intel 8086/186/286 is also available for Unix 4.2, VMS, and MicroVMS. $4000.

BSO Inc, 128 Technology Ctr, Waltham, MA 02254. Phone (617) 894-7800. TWX 710-324-0760.

Circle No 394



IEEE-488 INTERFACE

The GPIB-382 IEEE-488 interface features an onboard 80186 processor, 128k bytes of memory, and a data-transfer rate of 790k bytes/sec. Using this device, hardware and software architecture can perform real-time Unix applications. An onboard processor offloads GPIB-related processing from the host AT&T 3B2 computer and allows the computer to perform parallel processing. Also included are a standard NI-488 C language interface, an interactive control program, and a configuration program. $1795.

National Instruments, 12109 Technology Blvd, Austin, TX 78727. Phone (800) 531-4742; in TX, (800) 433-3488. TLX 756737.

Circle No 395

IEEE-488 SOFTWARE

IEEE-488 software for the Venix/86 and Xenix operating systems includes an interactive control program, a device handler, and configuration and diagnostic utilities.

New Probeye® Series 3000 TVS

Now you can get a better thermal image–

but you'll have to accept a trimmer package and a lower price

New Series 3000 TVS from the world's largest producer of infrared equipment combines a sharper infrared image with the flexibility to go wherever thermal imaging is needed.

Improved display resolution (200 lines) and superior RGB color output provide a crisper, more definitive picture of heat patterns in 16 distinct colors.

Lighter, more compact components plus wireless remote control operation get to more places, let you analyze thermal problems from a distance.

Third generation Series 3000 offers temperature coverage from −20 to 1500 degrees Celsius and with temperature resolution as fine as 0.1 degree Celsius.

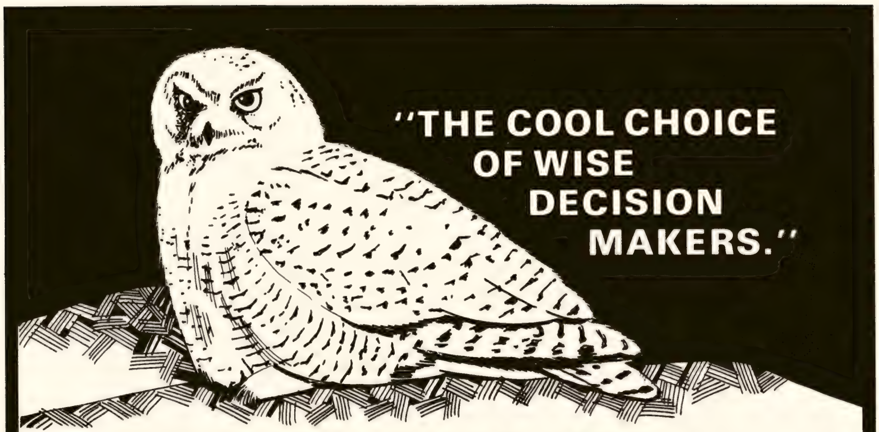
Microprocessor control features include user-selectable viewing options, direct real-time temperature readout and generation of graphics and alphanumerics.

The lower price includes more standard features than any other system existing today. In addition, you have a choice of desktop 10-inch monitor or compact 3-inch monitor plus a selection of quality accessories for specialized needs.

For more information or for a hands-on demonstration, write or call today. Hughes Aircraft Company, Probeye Marketing, 6155 El Camino Real, Carlsbad, CA 92008. Phone 619/931-3617.

HUGHES
AIRCRAFT COMPANY

CIRCLE NO 145



"THE COOL CHOICE OF WISE DECISION MAKERS."

5-MHz CMOS 8085 MICROPROCESSOR

- HIGH SPEED, LOW POWER CMOS ALTERNATIVE TO THE NMOS 8085
- AVAILABLE IN COMMERCIAL, INDUSTRIAL AND MILITARY TEMPERATURE RANGES
- PACKAGES INCLUDE PLASTIC, CERDIP, LCC, AND SIDE-BRAZED
- SPECIAL PACKAGING AND TESTING AVAILABLE

Call Nick Deeble at (617) 836-1014 or in the USA 1-800-267-7231

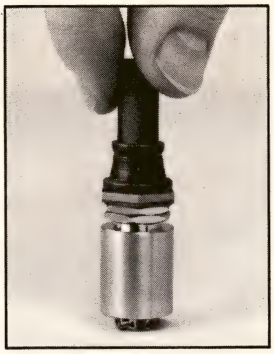
CALMOS®
Calmos Semiconductor
20 Edgewater St., Kanata, Ont., K2L 1V8 Tlx: 053-4501

CIRCLE NO 146

Proportional Joysticks
Small Size
Big Performance

They're only a little over an inch long and weigh under an ounce, but their performance is king-size.

Operation is easy and natural, promoting higher speed and accuracy in positioning and tracking tasks. Resolution is infinite, with continuous output and no dead zone. Rugged construction allows flawless operation even in severe environments. And mean time between failures is 200,000 hours, with a minimum of 10,000,000 cycles.



Small wonder these joysticks have been used so successfully in computer graphics, visual displays, fire control systems, hoists, vehicle control and robots, among other applications. Chances are they could be useful to you, too.

Want to find out? Just call or write us for more information.

MS Measurement Systems, Inc.
121 Water Street, Norwalk, CT 06854 203-838-5561

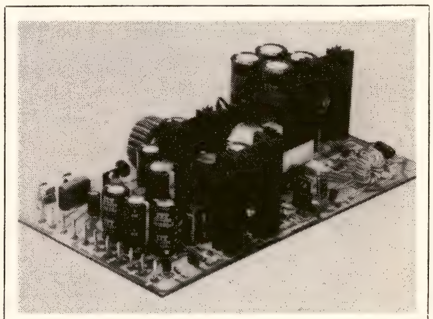
CIRCLE NO 147

INSTRUMENTATION & POWER SOURCES

Support packages for Venix/86, IBM Xenix, and SCO Xenix as well as language interfaces for True Basic and Better Basic work with the firm's GPIB-PC hardware or the GPIB adapter from IBM. You can perform a GPIB function (reading, writing, polling, etc) directly from a terminal with the available interactive control program. The language interfaces for True Basic and Better Basic allow you to write programs that then are able to communicate with the National Instruments GPIB hardware. Support packages, $200 each; language interfaces, $50.

National Instruments, 12109 Technology Blvd, Austin, TX 78727. Phone (800) 531-4742; in TX, (800) 433-3488. TLX 756737.

Circle No 396



100W SWITCHERS

The EP3500 Series 100W, triple-output switching power supplies consist of three models measuring 7.8×4.3×2.2 in. Available outputs are 5V at 8A, 12V at 4A, 12, −12, or 24V at 2A, 12 or +5V at 1A (linear regulated). Outputs two and three have pulse ratings of 6 and 4A, respectively. The 5V output has overvoltage protection. Operating temperature range is 0 to 70°C. The units are 75% efficient and accept 115/230V ac inputs. Line regulation is <100 mV over the input range. $1/W OEM qty. Delivery, eight to 10 weeks ARO.

Powerline, 10 Cochituate St, Natick, MA 01760. Phone (617) 655-7987. TWX 510-100-3630.

Circle No 397

EPROM PROGRAMMER

The EZ-Pro 198 and IBM PC software package can program 98 types of EPROMs and EEPROMs. The programmer features a 16-character×2-line LCD and a keyboard. You can program PROMs ranging from 16k to 512k bits using one front-panel socket by designating the device type from the keyboard. It incorporates both serial (RS-232C) and parallel (Centronics standard) ports as standard equipment. EZ-Pro 198, $895; software package, $200.

Zax Corp, 2572 White Rd, Irvine, CA 92714. Phone (800) 421-0982; in CA, (714) 474-1170. TLX 183829.

Circle No 398

PROM PROGRAMMER

The ECL-1 programmer programs all National Semiconductor and Monolithic Memory ECL PLDs. The device can interface to standard development systems via an RS-232C port and has stand-alone capabilities for duplication and verification when used in production programming. Included is a copy of Plan, a software package from National Semiconductor. $495.

International Microsystems Inc, 11554 C Ave, Auburn, CA 95603. Phone (800) 325-6028; in CA, (916) 885-7262.

Circle No 399

80386 MONITOR

The P-MON386ES monitor allows you to debug software written for the 80386 32-bit μP. The software included runs on the IBM PC/AT with DOS 3.1 or on an Intel System 286/310 with the Xenix 3.0 operating system. The monitor allows you to download programs into your target system, set hardware and software breakpoints, examine and modify memory and processor registers, and control program execution. In addition, you can patch code by writing directly to memory. $3495.

Intel Corp, Literature Dept W290, 3065 Bowers Ave, Santa Clara, CA 95051. Phone local office.

Circle No 400

THE 1750A IS HERE...
...AND WE'VE GOT IT!

Introducing the SECS 80/1750A, a high performance 16-bit single board microcomputer that combines the MIL-STD-1750A ISA and the SECS 80 MULTIBUS™!

FEATURES: Fairchild F9450 microprocessor • 64K words on-board memory • MIL-E-5400, MIL-E-16400, MIL-E-4158 • SECS 80 MULTIBUS compatibility • Ada®, JOVIAL, CORAL support.

The SECS 80/1750A computer operates with the full line of SECS 80 processors, memories and peripherals now available from TITAN/SESCO!

For more information on the SECS 80/1750A and our SECS 80 Militarized Computer Systems, use our Toll Free Number:

(800) 423-5527

®Ada is a reg. trademark of the U.S. Govt. (AJPO)
™MULTIBUS is a trademark of Intel Corporation

TITAN
SEVERE ENVIRONMENT SYSTEMS

20151 Nordhoff St., Chatsworth, CA 91311-6273
(818) 709-7100 • Telex 69-1404

CIRCLE NO 148

TRANSISTOR MODULE

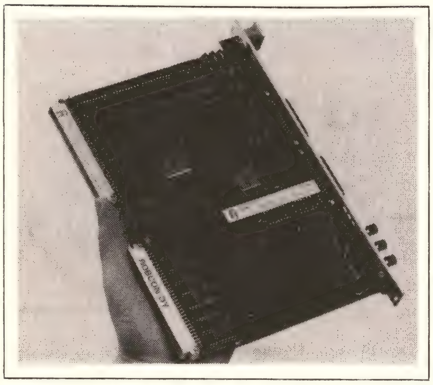
The SGS80DA020D Transpack power module links four power Darlingtons inside a TO-240AA package to provide a solid-state switch rated at 80A and 200V. The transistors are mounted to provide 2.5-kV isolation between the transistors and the package's mounting plate, allowing you to heat-sink the modules without the use of external mica insulators. Integral soft-recovery freewheeling diodes protect the transistors during switching transients and also minimize ringing and radiated noise. Half-bridge connected versions of the module are also available. $18 (1000).

SGS-Ates, Via C Olivetti 2, 20041 Agrate Brianza, Italy. Phone (039) 65551. TLX 330131.

Circle No 401

SGS-Semiconductor Corp, 1000 E Bell Rd, Phoenix, AZ 85022. Phone (602) 867-6100.

Circle No 419

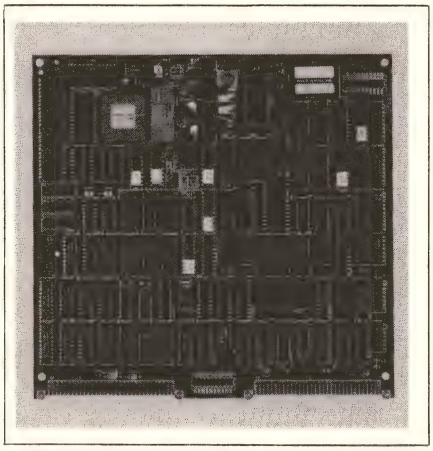


CPU CARD

The CPU-020 VME Bus CPU card, based on a 68020 µP, uses a MVMX32 P2-connector interface for high-speed 32-bit memory expansion. Onboard memory includes 1M byte of dual-ported RAM with a cycle time of 310 nsec and sockets for as much as 64k bytes of EPROM firmware. Additional processor support includes a 68881 math coprocessor, a 68851 demand-paging memory-management unit, and two RS-232C serial communications channels. You configure one of these channels for RS-422 operation. The board can address as much as 4G bytes of memory, with the VME Bus and MVMX32 bus accessed via two separate gigabyte address sections. The VME Bus interface includes a priority (PRI) bus arbiter, a dynamically reconfigurable 4-level bus requester, four programmable bus-release modes, and a 7-level dynamically configurable interrupt handler. Fin M 27,500.

Robcon-Euroka Electronics, Box 9, 00391 Helsinki, Finland. Phone 0-541144. TLX 125316.

Circle No 402

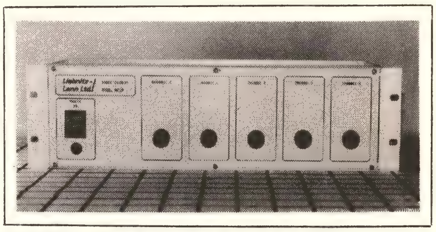


IMAGING BOARD

Capable of accepting interlaced or noninterlaced input from CCD cameras, vidicon-based cameras, or VCR equipment, the Multibus II-compatible NEX-MTB-II-001 video data-acquisition board digitizes a video signal to 8-bit resolution and features a 20-MHz conversion rate. You can synchronize the video camera and digitizer via external or onboard logic. Operating as a secondary master on the iLBX II bus, the board performs 32-bit transfers of digitized video information directly into iLBX II-based memory. Suitable memory cards are available. Video memory capacity can be as large as 16M pixels, arranged as a 4096×4096 array. The board allows you to individually correct the white level of each pixel in a line of as many as 4096 points with 0.4% resolution. Software configuration is accomplished via interconnect space on the board's iPSB bus interface. With the camera adapter module mounted on the board, the board occupies two Multibus II card slots. FFr 40,000.

Centralp Automatismes, 21 rue Marcel-Pagnol, 69200 Venissieux, France. Phone 78-759230. TLX 900205.

Circle No 403



VIDEO ANNOTATOR

The Model 107LR video annotator allows you to superimpose data or text onto five independent camera inputs, via a standard RS-232C serial link. The unit features two font sizes in upper and lower case. Alternatively, you can define your own character font. A character-edging facility maintains legibility of the characters regardless of the picture background. Video bandwidth is 10 MHz, and an independent phase-locked loop for each channel allows you to synchronize the channel to any video standard input. From £4000.

Liebnitz Lann Ltd, Willowbank House, Willowbank Rd, Aberdeen AB1 2YG, UK. Phone (0224) 580498. TLX 739403.

Circle No 404

RADIO RECEIVER

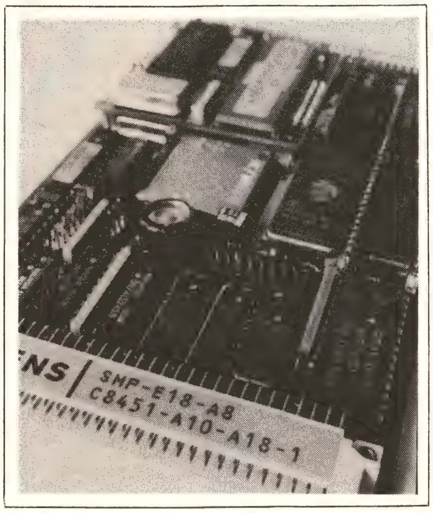
Suited to radio-communication and -monitoring applications, the EK085 receiver operates over the frequency band from 10 kHz to 30 MHz. You can use it to receive amplitude-modulated, single-sideband, Morse, and FSK signals. Standard data interfaces are available for the direct connection of teletypes and weather-chart or facsimile recorders. Filter options allow you to tailor the receiver's bandwidth to specific applications. Internal µP control automatically selects bandwidths, optimum gain control, and teletype stop-commands suitable for the class of transmission selected. A 100-channel nonvolatile memory stores complete receiver settings, which you can select individually or automatically in sequence. It is also possible to select frequency scans with programmable start and stop frequencies, step size, and dwell time. An interface provides remote control of the receiver and the ability to place multiple EK085 receivers in master-slave configurations. DM 30,000 to DM 40,000.

Rohde & Schwarz GmbH & Co KG, Muhldorfstr 15, 8000 Munich 80, West Germany. Phone (089) 41292625. TLX 523703.

Circle No 405

Rohde & Schwarz Inc, 13 Nevada Dr, Lake Success, NY 11042. Phone (516) 488-7300.

Circle No 421



CPU CARD

Suited to I/O-intensive tasks, the SMP-E18-A8 CPU card for SMP Bus systems features an 8-MHz 80188 µP, two RS-232C serial ports, a 16-bit parallel input port, and an 8-bit parallel output port, which you can configure as a Centronics compatible interface. In addition, the card has two byte-wide memory sockets, a watchdog timer, three 16-bit programmable timer/counters, two DMA channels, and eight interrupt inputs. The memory sockets accept EPROMs with capacities as high as 64k bytes, including EEPROMs. One of the sockets also accepts as much as 32k bytes of static RAM. You can add an optional 8087 coprocessor on a piggyback board. DM 2045.

Siemens AG, Zentralstelle für Information, Postfach 103, 8000 Munich 1, West Germany. Phone (089) 2340. TLX 5210025.

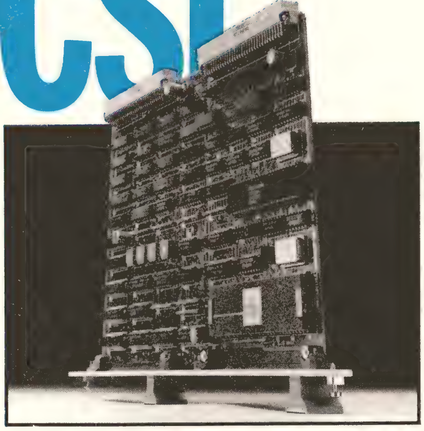
Circle No 406

BIT-SLICE ASSEMBLER

Wrtten in C and running under MS-DOS or Unix, the BMasm assembler allows you to develop your own programs for any microcode-programmable bit-slice processor system. To use the assembler, you first input the instruction set and

VMEbus TO SCSI INTERFACE

TO: OPTICAL-MAGNETIC-DISC-TAPEDRIVER, LASERPRINTERS AND OTHER INTELLIGENT PERIPHERALS



Application of the NCR 5386 guarantees conformance to the SCSI specifications.
The four channel DMA controller gives additional power to your systems.

COMPCONTROL

COMPCONTROL INC.
15466 Los Gatos Blvd. Suite 109-365
LOS GATOS, CALIFORNIA 95030
Phone: 408-356-3817
Twx: 510-601-2895

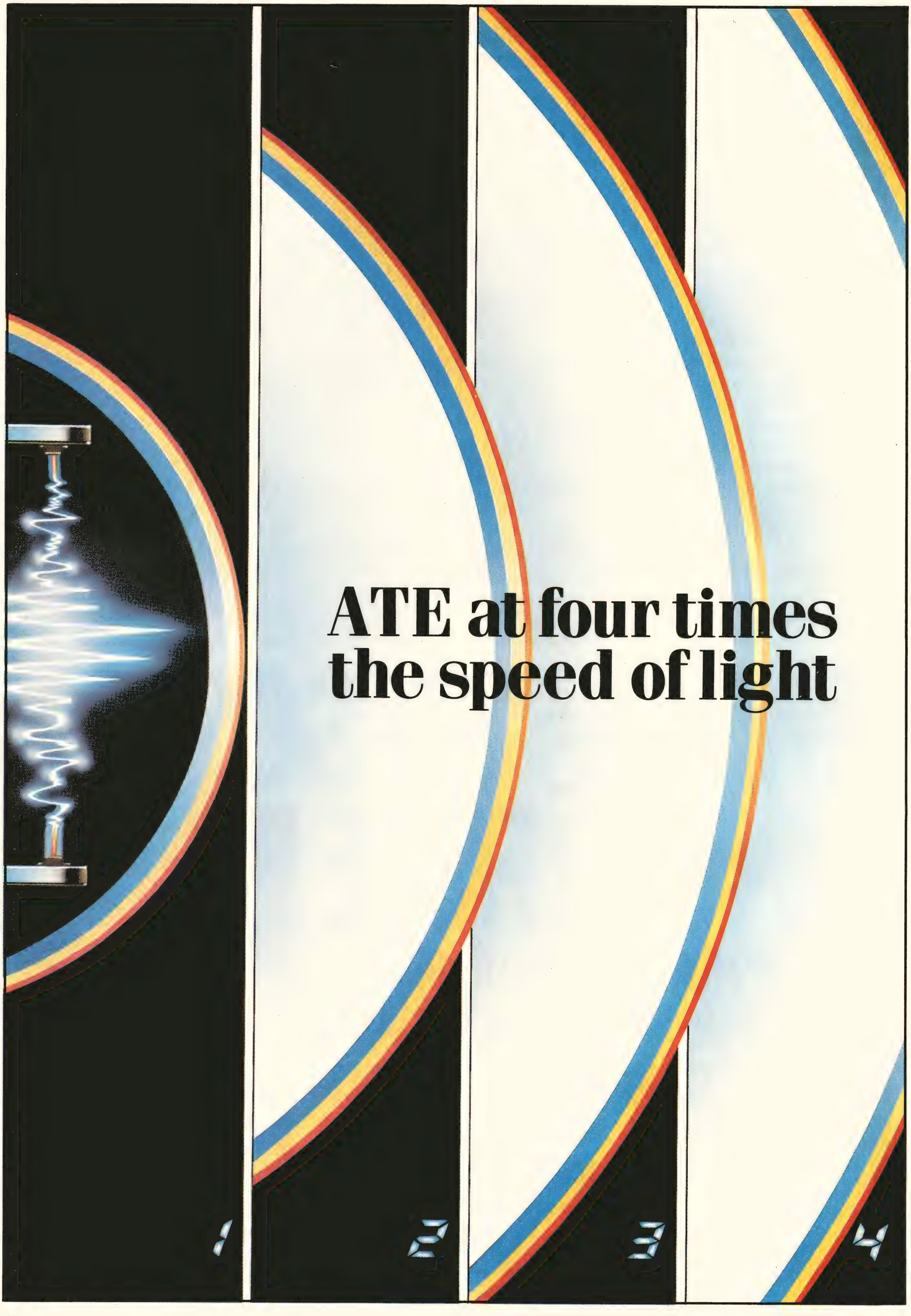
Member of
the VMEbus International Trade Association
VITA

CIRCLE NO 149

VMEbus

COMPCONTROL B.V. EUROPE
Stratumsedijk 31, P.O. Box 193
5600 AD Eindhoven, Holland
Telefoon (040) 124955
Telex 51603 compc nl

ATE at four times the speed of light



So fast, it catches the edge of light not once, but four times.

Imagine sitting in a totally darkened room with these pages open in front of you. Now switch on the light.

In the almost instantaneous moment the light takes to cross **one page**, Series 700 ATE could pinpoint the edge of that light not just once, but **four times**.

Even more incredibly, it could do so with an operator ease that achieves the lowest cost-per-fault in Europe.

Series 700 – Fast, accurate ... and simple.

There is only **one** cost effective way to test today's fast boards. At full operating speed. And with **30 MHz performance/10 MHz in-circuit** data rates plus **200 picosecond resolution (200 picoseconds ≏ 2.5″ (6 cms) at the speed of light).** There's only one system capable of testing at full speed – **Series 700.**

Choice: With Series 700 you can match performance to application:

- **730** for Performance In-circuit
- **720** for Performance Functional
- **750** for the ultimate Performance in Combinational systems

Unique Features: Series 700 offers incredibly high speeds, fine timing resolution and pattern handling capabilities through the unique ACCELERATOR pattern processor, as well as 16K RAM, full signature analysis on every test channel and automatic deskew facility.

Analyst: Series 700 is equipped with this provenly outstanding multi-diagnostic management package as well as test programs that give you the ability to handle new devices such as Application Specific Integrated Circuits (ASIC), gate arrays and semi-custom chips.

Simplicity: But far and away Series 700's most important feature for the production manager is the sheer operational capability.

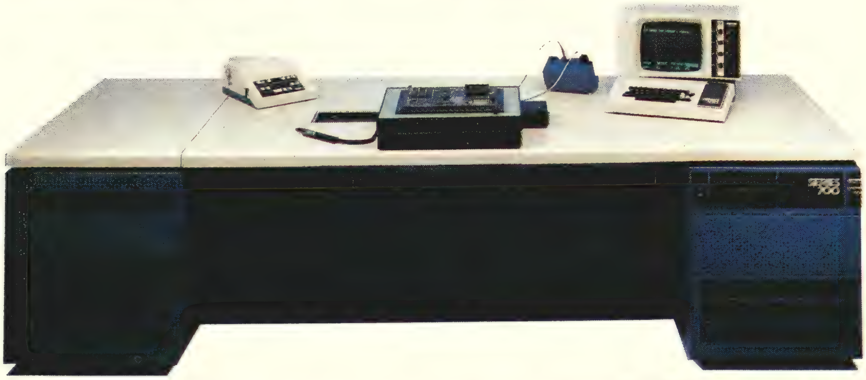
- Series 700 finds more faults
- Series 700 is more cost-effective
- Series 700 has quicker expansion potential for the future.

And Series 700 is so accurate there's no need for fault analysis.

It's that simple!

Factron Capability: already includes Test Area Management, incoming inspection, production test, repair, robotics, materials handling, fixtures and consultancy. All more evidence of Factron's commitment to the Factory of the Future. And of course there is Factron's long term research into artificial intelligence **and** technology.

Check the Factron Series 700 for yourself. As a return on investment, it is the best ATE in Europe.



FACTRON SCHLUMBERGER, Europe: Ferndown Industrial Estate, Wimborne, Dorset BH21 7PP, U.K. Tel: (0202) 893535

FACTRON SCHLUMBERGER, U.S.A: 299 Old Niskayuna Road, Latham, New York 12110. Tel: (518) 783-3600
NISSEC SCHLUMBERGER, Japan: 1-2-10 Hirakawacho, Chiyoda-Ku, Tokyo 102. Tel: (03) 2397411
SCHLUMBERGER SYSTEMS, Singapore: 12 Lorong Baker Batu, Singapore 1334. Tel: 7466344

BENELUX Holland Tel: (040) 457745, FRANCE Te': (1) 4687 3243, GERMANY Tel: (089) 638110, ITALY Tel: (2) 9233474

FACTRON AGENTS/DISTRIBUTORS
SPAIN Tel: (1) 2624913, SWITZERLAND Tel: (31) 44.2711, TURKEY Tel: (1) 338 3529

FACTRON
Schlumberger

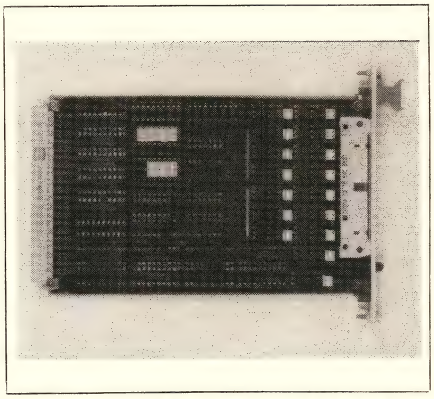
Partners in Productivity

CIRCLE NO 150

hardware charcteristics of your target processor. You can then assemble source code in the normal way. The assembler has a free-format input and suits applications that involve multiprocessor boards or that require high-speed code execution—for example, real-time graphics, digital signal processing, or fast language processing. Included in the software is a microcode debugger, which allows you to set breakpoints, single-step the program, or display the contents of registers and data/memory locations. £6000 for a single-site licence.

benchMark Technologies Ltd, 2 Lower Teddington Rd, Hampton Wick, Kingston-upon-Thames, Surrey KT1 4ER, UK. Phone (44) 019434393. TLX 8952387.

Circle No 407



DIGITAL INPUT BOARD

All input channels on this board are protected against voltage inversion and overshoot; you can configure any channel to generate a change-of-state VME Bus interrupt. The board operates on the VME Bus as a slave device. $495.

Philips, Industrial & Electro-Acoustic Systems Div, Box 523, 5600 AM Eindhoven, The Netherlands. Phone (040) 757005. TLX 51573.

Circle No 408

Signetics Corp, 811 E Arques Ave, Sunnyvale, CA 94086. Phone (408) 991-2000.

Circle No 420

FILTER DESIGN

The Filter I: Edge-Coupled Stripline (ECS) and Filter II: Edge-Coupled Microstrip (ECM) help you design a filter within seconds, according to the manufacturer, and give you the option of analyzing the response. If you need help during your design or analysis, you can call up information on how to select parameters. If you need to change a filter's parameters, an optional feature automatically reconfigures the design. These programs allow you to specify electrical input, the materials used in passive components, and other items affecting the characteristics of a filter. The programs use mathematical filter models for complete analysis of insertion loss, VSWR, phase and time delay, and impedance and admittance. You can enter empirical corrections for inclusion in the calculations. You can also use ECM and ECS in conjunction with Touchstone, the manufacturer's linear-circuit design-simulation and optimization program, which can create graphics plots of the filter's performance. ECM and ECS run on the IBM PC and compatibles. $3500 to $7500 each, depending on options selected.

EEsof Inc, 31194 La Baya Dr, Westlake Village, CA 91362. Phone (818) 991-7530. TLX 384809.

Circle No 409

ENHANCED OS

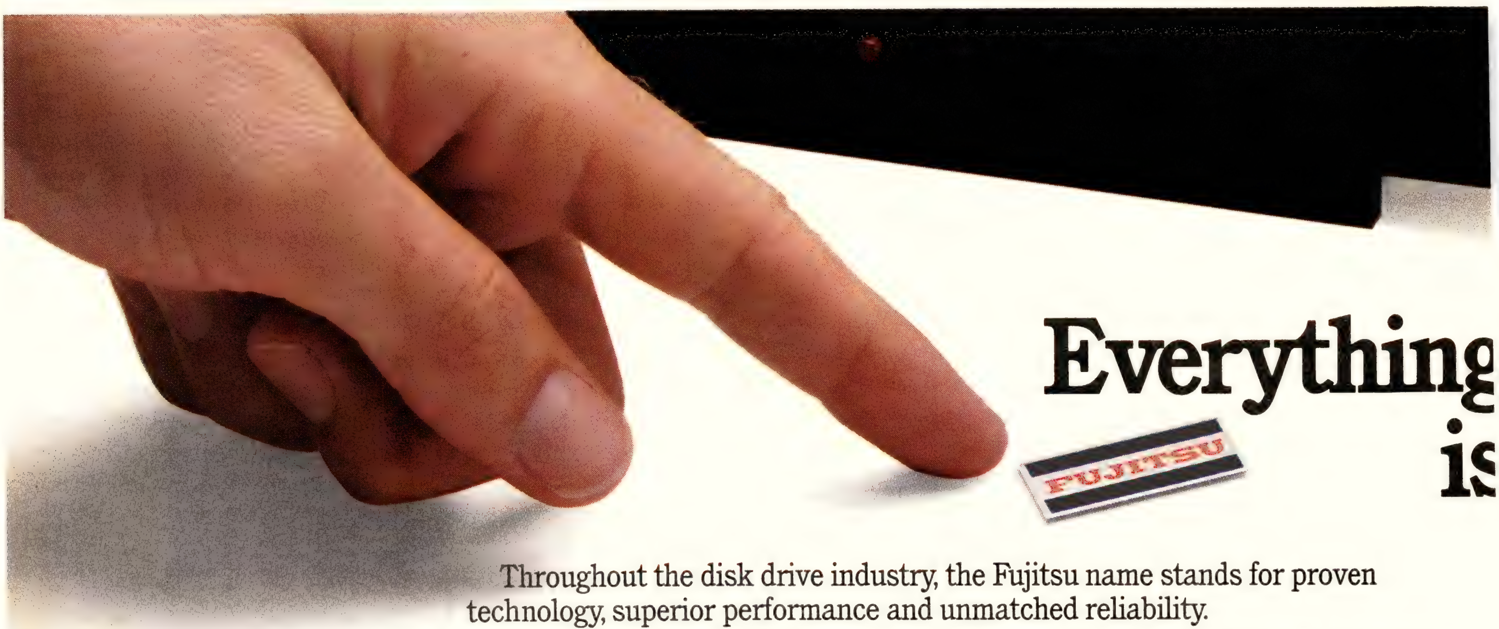
The CP/M-68K Revision 1.3, an updated version of the vendor's operating system for 68000-type processors, offers a higher speed than its predecessor; some bugs have been fixed as well. Type-ahead keyboard buffering supports interrupts. The manufacturer includes support for its Spuz, an 8-MHz Z80 slave processor that allows you to run 8-bit system programs in a 68000 environment. The system's C compiler, with the addition of a slave processor, allows you to use 8-bit word processors to develop C source code. Forth-83 is also furnished and includes utilities to read and write CP/M-compatible files. This system runs with the manufacturer's 10-MHz 68000-based CPU board, System Support 1 board, Disk 1A and Disk 3 floppy- and hard-disk controller boards, and Interfacer 3 and 4 I/O boards. A minimum of 256k bytes of memory is necessary. $400; upgrade, $125.

Viasyn Corp, 26538 Danti Ct, Hayward, CA 94545. Phone (415) 786-0909.

Circle No 410

VAX DATA PACKAGE

The MicroVMSLib is a set of 54 subroutines, which can be called by an application program written in any high-level language to directly control A/D and D/A converters and



Throughout the disk drive industry, the Fujitsu name stands for proven technology, superior performance and unmatched reliability.

Throughout the world, the name represents a company that comes through with products instead of promises.

And when it comes to 5¼" Winchester disk drives, Fujitsu America has a new 172MB drive, with units available today for your evaluation.

It's the newest member of our 5¼" disk drive family—and it's based on the same proven technologies. It's fully compatible with industry standards. And it gives you a significant price/performance advantage.

This drive represents a major step in the evolution of your multi-user system. And Fujitsu America has the technology, the strength and the experience to help you continue on that growth path.

real-time clocks. You can transfer data between a converter and a disk file at rates as fast as 50,000 samples/sec using an RQDX2 disk controller. A more modern disk controller may permit even higher rates. The software's architecture permits you to transfer large volumes of data without losing a single data point during the process, the vendor claims. The interactive installation procedure, with prompts, on-line help, and an automatic verification procedure, permits a user with little knowledge of the internal workings of MicroVMS to build a system-specific configuration. The error-reporting mechanism checks for programming errors, syntax and usage errors, and any attempts to operate the analog I/O interfaces in illegal modes. It provides three modes of data collection (single word, single buffer, and multibuffer); data transfer to system memory or disk; three channel-selection modes (single channel, all channels, channel scan); five triggering options; and support for multiple users and multiple analog I/O devices. The software supports programmed I/O boards from this company and DEC and this company's DMA boards. Initial license, $1995.

Data Translation Inc, 100 Locke Dr, Marlboro, MA 01752. Phone (617) 481-3700. TLX 951646.

Circle No 411

DEVELOPMENT AID

The Pathmaker, an extension of the company's database and development environment, provides a menu-driven interface that guides you step-by-step through the process of developing Cobol application programs on the company's computers. Each menu offers options that you can select by simply filling in blanks using English key words, or by pressing a function key on the keyboard. On-line help is available from every screen. You can use a full-screen interactive editor to design the terminal screens through which the end-user communicates with the application. The program then automatically generates Cobol source code to produce these screens. It also provides features for developing the back-end database portions of on-line applications. These features include a library of database functions that you can select and incorporate into applications without having to write any code. The program supports the Cobol language (including the Cobol 85 standard) for developing specialized database functions. Initial license fee, per EXT system, $3500; per NonStop II or TXP system, $7500.

Tandem Computers Inc, 19333 Vallco Pkwy, Cupertino, CA 95014. Phone (408) 725-6000.

Circle No 412

this name represents built into these 5¼″ drives.

So no matter what capacity 5¼″ drive you need, you can be sure of its performance, reliability and delivery. We keep close control of all three by manufacturing virtually every component of our drives ourselves. And we recently opened a plant that adds 220,000 square feet to our 5¼″ and 3½″ manufacturing capacity.

For more information about Fujitsu's full family of 5¼″ drives, call (408) 946-8777. Or write Fujitsu America, Inc., Storage Products Division, 3055 Orchard Drive, San Jose, CA 95134-2017.

When you want the best in data storage technology—and you want it now—just remember our name.

Model	M2233	M2235	M2243	M2246E
Capacity (MB) (unformatted)	13	27	86	172
Access Time (msec)	95	83	33	25
Interface	ST506/412	ST506/412	ST506/412	ESDI
Transfer Rate (KB/sec)	625	625	625	1250
Technology	Composite ferrite heads, Oxide media			

We're developing technology for you.

FUJITSU

FUJITSU AMERICA

CIRCLE NO 151

© Fujitsu America, Inc., 1985. All rights reserved.

Be An Author!

When you write for EDN, you earn professional recognition. And you earn $75 per published magazine page.

EDN publishes how-to design application information that is read by more than 137,000 electronic engineers and engineering managers worldwide. That's an audience that could belong to you.

If you have an appropriate article idea, please phone Jon Titus, Senior Editor, at (617) 964-3030 or send a proposal and outline to him at 275 Washington Street, Newton, MA 02158-1630. For a FREE EDN Writer's Guide–with tips on how to write for EDN and other technical publications–please circle number 301.

EDN

First in Readership among Design Engineers and Engineering Managers in Electronics

BUSINESS/CORPORATE STAFF

F Warren Dickson
Vice President/Publisher
Newton, MA 02158
(617) 964-3030
Telex 940573
Diann Siegel, Assistant

Peter D Coley
Associate Publisher/
Advertising Sales Director
Newton, MA 02158
(617) 964-3030
Stacey Vorias, Assistant

NEW ENGLAND
Bob Sommer, Regional Manager
275 Washington St
Newton, MA 02158
(617) 964-3030

STAMFORD 06904
George Isbell, Regional Manager
8 Stamford Forum, Box 10277
(203) 328-2580

NEW YORK CITY 10016
Daniel J Rowland, Regional Manager
Chris Platt, Regional Manager
475 Park Avenue South
(212) 576-8014
(212) 576-8017

PHILADELPHIA AREA
Steve Farkas, Regional Manager
999 Old Eagle School Rd
Wayne, PA 19087
(215) 293-1212

CHICAGO AREA
Clayton Ryder, Regional Manager
Randolph D King, Regional Manager
Cahners Plaza
1350 E Touhy Ave, Box 5080
Des Plaines, IL 60018
(312) 635-8800

DENVER 80206
John Huff, Regional Manager
Joseph A Vitiello, Regional Manager
270 St Paul St
(303) 388-4511

DALLAS 75234
Don Ward, Regional Manager
13740 Midway, Suite 515
(214) 980-0318

SAN JOSE 95128
Walt Patstone, Regional Manager
Bill Klanke, Regional Manager
Philip J Branon, Regional Manager
Mark Holdreith, Regional Manager
3031 Tisch Way, Suite 100
(408) 243-8838

LOS ANGELES 90064
Charles J Stillman, Jr
Regional Manager
12233 W Olympic Blvd
(213) 826-5818

**ORANGE COUNTY/
SAN DIEGO 92715**
Ed Schrader, Regional Manager
Jim McErlean, Regional Manager
18818 Teller Ave, Suite 170
Irvine, CA
(714) 851-9422

PORTLAND, OREGON 97221
Pat Dakin, Regional Manager
Walt Patstone, Regional Manager
1750 SW Skyline Blvd, Box 6
(503) 297-3382

**UNITED KINGDOM, THE NETHERLANDS,
SCANDINAVIA**
Jan Dawson, Regional Manager
39A Bowling Green Lane
London EC/1R/OBJ UK
44-1-278-2152
Telex: 28339

BELGIUM/FRANCE
Robert Broekman
American Publishers Representatives
4 Rue Robert de Flers
75015 Paris, France
33-1-46099595
Telex: 270560

GERMANY/SWITZERLAND
Wolfgang Richter
Sudring 53
7240 Horb/Neckar
West Germany
49-7451-7828; TX: 765450

AUSTRIA
Igal Elan
Elan Marketing Group
Neutor g 2, Box 84
1013 Vienna, Austria
43222-663012, 638461

SOUTHERN EUROPE
Igal Elan
Elan Marketing Group
13 Haifa St, Box 33439
Tel-Aviv, Israel
Tel: 972-3-268020
TX: 341667

FAR EAST
Ed Schrader, Director of Sales
18818 Teller Ave, Suite 170
Irvine, CA 92715
(714) 851-9422; Telex: 183653

TOKYO 107
Kaoru Hara
Dynaco International Inc
7-2-8 Minamiaoyama
Minato-Ku,
Tokyo 107, Japan
Tel: 81-3-409-4569
Fax: 81-3-499-4554
Telex: J28899

TAIWAN
Owen Wang, Gen Mgr
Ace Marketing Inc
Box 26-578 Taipei, Taiwan
Republic of China
86-2-703-4272
Telex: 14142

KOREA
Korea Media Inc
Rm 322, A-11 Bldg 49-4,
Hoihyundong 2-Ka, Chung-Ku
CPO Box 2314, Seoul, Korea
Tel: 82-2-755-9880
Telex: K26249

SINGAPORE
Cheny Tan Associates
20 McCallum 17-01/02
Asia Chambers
Singapore 0106
Tel: 65-2222893
Telex: RS 35983 CTAL

PRODUCT MART
Joanne Dorian, Manager
475 Park Avenue South
New York, NY 10016
(212) 576-8015

**CAREER OPPORTUNITIES/
CAREER NEWS**
Roberta Renard
National Sales Manager
475 Park Avenue South
New York, NY 10016
(212) 576-8048

Janet O Penn
Eastern Sales Manager
475 Park Avenue South
New York, NY 10016
(212) 576-8049

Dan Brink
Western Sales Manager
2041 Business Center Dr
Suite 109
Irvine, CA 92715
(714) 851-9422

Diann Siegel
Boston Sales Representative
Newton, MA 02158
(617) 964-3030

Maria Cubas
Production Assistant
(212) 576-8045

Cahners Magazine Division
William Platt, President
Terry McDermott, Executive Vice President
Tom Dellamaria, VP/Production & Manufacturing

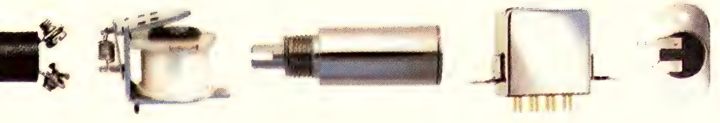
Circulation
Denver, CO: (303) 388-4511
Sherri Gronli, Group Manager
Eric Schmierer, Manager

Reprints of EDN articles are available on a custom printing basis at reasonable prices in quantities of 500 or more. For an exact quote, contact Ernie Kummer, Cahners Reprint Service, Cahners Plaza, 1350 E Touhy Ave, Box 5080, Des Plaines, IL 60018. Phone (312) 635-8800.

THE WRONG RELAY CAN MAKE YOUR PC BOARD APPEAR TO BE SOMETHING IT'S NOT.

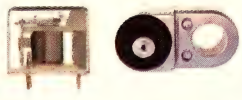
Don't let power switching relays be the weak links on your PC board designs. Rely on the Airpax family of PC board-mountable relays to deliver the reliable, consistent performance you've integrated into every other facet of your design. Airpax power switching relays combine peace of mind with economy and real design freedom. Base your choice on size, contact ratings, coil configurations, standard or special materials, or virtually any other criteria. And rest assured the relay you choose will not turn your best designs sour. Available in SPST through DPDT. One amp through 15 amps, plus gold cross bar contacts for low-level switching. UL and CSA recognition.

Call us today and ask about the Airpax power switching relays currently specified around the world for television circuitry, office equipment, appliances, alarm systems, door openers, automotive controls and hundreds of other PC board applications. Airpax Corporation, Frederick Division, Husky Park, Frederick, MD 21701. (301) 663-5141. A North American Philips Company.

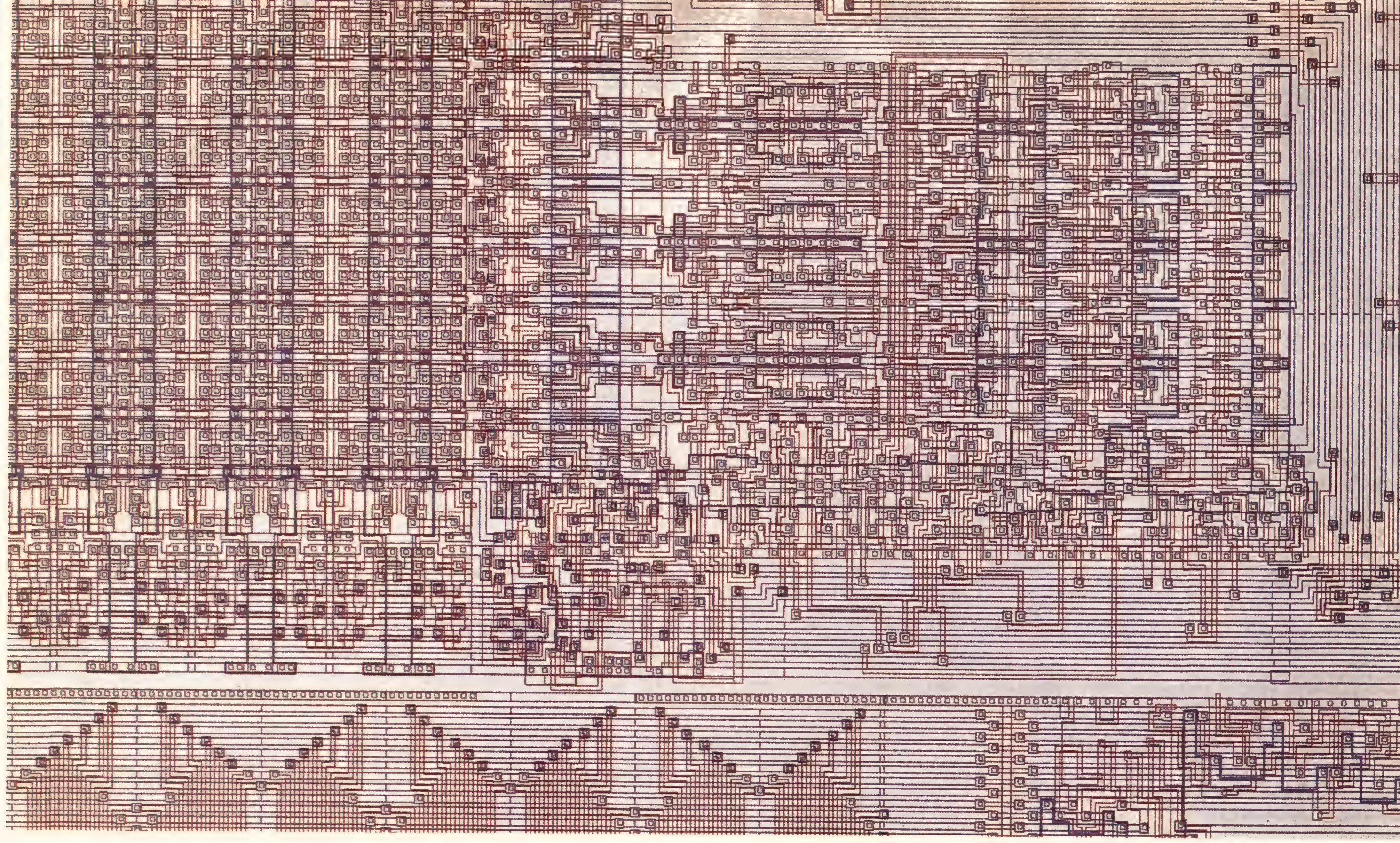


AIRPAX®

FREDERICK DIVISION



CIRCLE NO 158



CALCOMP'S RESOLUTIONARY ADVANCE IN ELECTROSTATIC COLOR PLOTTERS.

Vivid color comes to high resolution electrostatic plotters.

CalComp introduces its new 5800 Series. Resolution is up to four times that of any other color electrostatic plotter—an incredibly sharp 160,000 dots-per-square-inch. The result is better definition, sharper lines and a smoother transition of colors.

Unlike other electrostatic plotters, the 5800 Series features random vector input. This eliminates the need for add-on controllers that take up extra space. And the 5800 provides internal rasterization and color separation to offload the host computer and increase plot throughput.

Registration is unmatched. Our patented electronic system registers each pass without any mechanical adjustment. Simply, there are no moving parts so you are assured of a new standard in accuracy and reliability.

And your maintenance will be minimal due to CalComp's exclusive Enviroclean™ toning system. Extensive diagnostics are built right in. And each plotter is backed by CalComp's worldwide field service network.

For a closer look at these resolutionary plotters, write CalComp, P.O. Box 3250, Anaheim, CA 92803. Or call 1-800-CALCOMP.

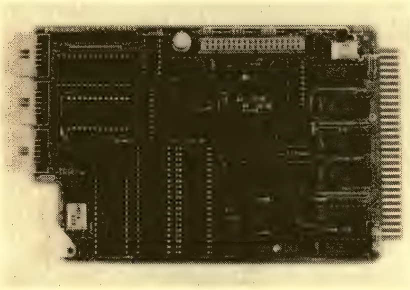
CALCOMP
A Sanders Company

CIRCLE NO 152

EDN
PRODUCT MART

This advertising is for new and current products.

Please circle Reader Service number
for additional information from manufacturers.

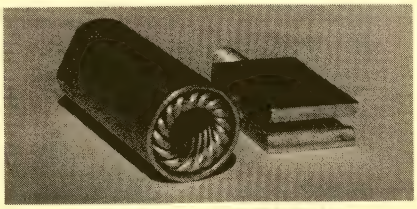


CMOS 80C88 SINGLE BOARD STD BUS COMPUTER

Features the 16-bit 8088 with 8087 coprocessor socket and 1 Mbyte addressing, On-board functions include 2 JEDEC 28-pin memory sockets for up to 128K bytes of RAM. EPROM, or EEPROM. Includes one RS-232/RS-422 serial port, 8259A interrupt controller, 3 16-bit counter/timers, SBX connector, and Watchdog timer. Available in NMOS/TTL or CMOS from

WinSystems, Inc.
PO Box 121361
Arlington, TX 76012
817/274-7553

CIRCLE NO 200



BLADE & CYLINDRICAL SINGLE POLE CONNECTORS

High current, low voltage drop connectors virtually eliminate the need for bussing or current splitting. Features include:

- Current up to 1000 amps
- Standard sizes and styles "off-the-shelf"
- Mating to pin or direct to bus bar
- Available in custom designs

Call (415) 490-4200 or write:

Elcon Products International Co.
P.O. Box 1885, Fremont, CA 94538
TWX: 910-381-7026

ELCON
PRODUCTS INTERNATIONAL COMPANY

CIRCLE NO 201

EE/EPROM PROGRAMMER...with Eraser...the "BEST" for $1295.*

DIGELEC Model 824

- ■ RAM 512K, upgradeable to 2048K
- ■ Programs 2716 to 271024, upgradeable
- ■ MOS, CMOS, 40-pin micro P's, no adapters
- ■ Programs virtually all mfg's, 220 + devices
- ■ Time-saving quick-pulse & Int. algorithms
- ■ Complete stand-alone editing, 16-char. display
- ■ RS-232 Remote control, translation formats
- ■ Optional IBM-PC/AT menu-driven S.W.

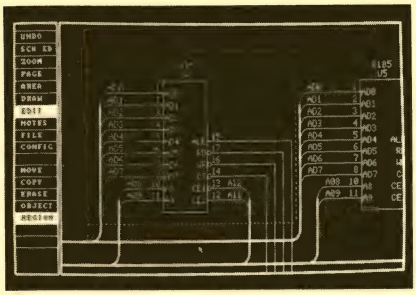
*SPECIAL INTRODUCTORY PRICE

PHONE 201-493-2420

DIGELEC, Inc., 1602 Lawrence, Ocean, NJ 07712

■ **Also mfg of LOGIC, GANG, OEM, PC Board, & UNIVERSAL PROGRAMMERS**

CIRCLE NO 202

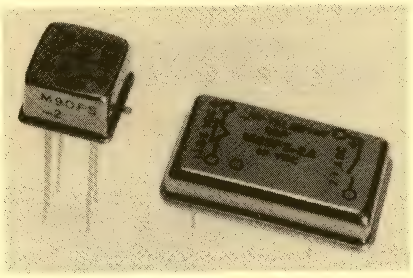


FREE DEMO DISK

SCHEMA is a complete, integrated schematic drawing software package for IBM Personal Computers. Use **SCHEMA** with your PC to draw schematics and automatically generate design documentation such as Wire and Net Lists, Bills of Materials, Design Rule Checks, etc. **SCHEMA** is $495 and supports most common PC hardware configurations. Call or write today for a *free* demo disk and brochure.

OMATION INC.
1701 N. Greenville Ave., Suite 809
Richardson, TX 75081
(214) 231-5167

CIRCLE NO 203



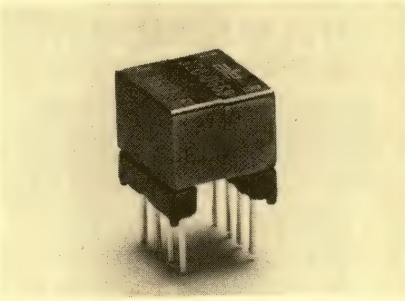
DC SWITCHING HYBRIDS (SHORT CIRCUIT PROTECTED)

- Integrated short-circuit protection
- Functions as a Remote Circuit Breaker
- Power FET output
- Fast switching speed
- Low on-resistance (0.15 ohms typ.)
- Virtually no offset voltage
- Opto isolation up to 1200 volts
- Hybrid microelectronic design
- Meets MIL-STD-704A surge and spike requirements
- Input TTL compatible
- 3.8 to 32.0 volt input range
- Constant current input
- Designed to MIL-R-28750
- Available to the screening requirements of MIL-STD-883
- Radiation hardening levels data available
- M85FS-2A 2.1 Amps at 60VDC
  M90FS-2 1 Amp at 60VDC

$146/$189 at 100 pieces

Teledyne Solid State
12525 Daphne Avenue, Hawthorne California 90250 (213) 777-0077

CIRCLE NO 204



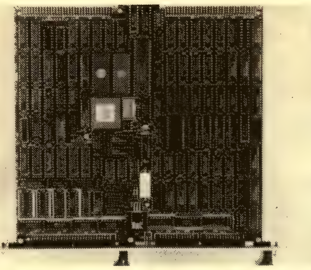
TOKEN RING LOCAL AREA NETWORKS BUS COUPLING TRANSFORMERS

AIE Magnetics introduces a series of pulse transformers designed for bus coupling of differential Manchester encoded data in the frequency range of 1 to 4 MHz to a 150 ohm shielded pair bus, in conformance to IEEE Standard 802.5 for both transmitted and received signals. Sufficient ET is provided to accommodate the longer pulse widths of the J and K non-data codes as well as the phantom loop current of 2ma.

AIE Magnetics
701 Murfreesboro Road, Nashville, Tennessee 37210
615/244-9024

CIRCLE NO 205

To advertise in Product Mart, call Joanne Dorian, 212/576-8015



DVME-715 Intelligent SMD Disk Controller

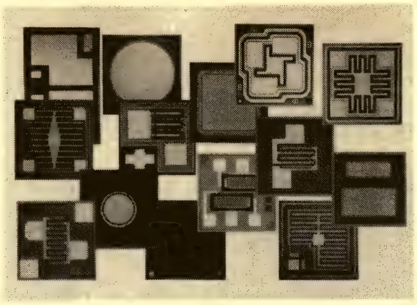
- 8 MHz 68000 CPU
- Supports two SMD-compatible disk drives
- Data transfer rates to 20 Mb/s
- 1:1 interleaving
- Zero latency reads
- On-board buffering for at least one track of data
- High speed DMA for performance enhancement
- High level command set

For more information on the DVME-715, contact:

DY-4 Systems Inc.
1475 S. Bascom Ave., Suite 202
Campbell, CA 95008 (408) 377-9822

DY-4 SYSTEMS INC.

CIRCLE NO 206

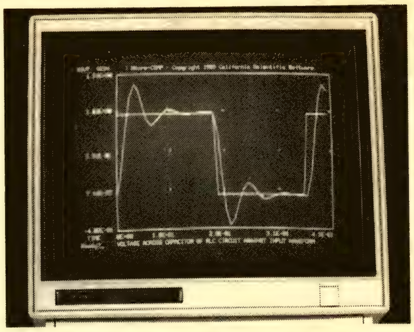


SEMICONDUCTOR CHIPS.

Sprague silicon planar epitaxial semiconductor devices feature silicon-nitride passivation, large bonding pads, symmetrical designs, sputtered gold backsides. Standard JFET and Bipolar Transistors, Diodes, and MOS Capacitors in stock. Non-standard types available quickly. All devices visually inspected, 100% d-c probe-tested. All parameters guaranteed to an LTPD of 10%. Four package options. Write for Catalog CN-164K to:

SPRAGUE ELECTRIC COMPANY
41 Hampden Road, P.O. Box 9102
Mansfield, MA 02048-9102

CIRCLE NO 207

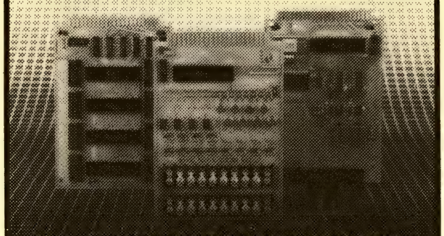


Free Engineering Software Brochure

Micro-CSMP simulates any system including: • Control and Servo systems • Robotics • High Order Filters • Chemical Processes • Stress & Strain. A full implementation of IBM's S/360 CSMP, Micro-CSMP produces graphical results in minutes, typically requiring 10-20 lines of input. **LSAP analyzes linear systems** producing Bode, Nyquist, and Transient Response plots, and Root-Locus diagrams. Micro-CSMP is $900, LSAP is $450 for PC-DOS or MS-DOS systems. **California Scientific Software**, 25642 Hazelnut, El Toro, CA 92630 (714) 581-7654.

CIRCLE NO 208

6800/6809 Micro Modules



OEM 6800/6809 MICROCOMPUTER MODULES for dedicated control and monitoring. Interfaces for sensors, transducers, analog signals, solenoids, relays, lamps, pumps, motors, keyboards, displays, IEEE-488, serial I/O, floppy disks.

WINTEK

Wintek Corp.
1801 South Street
Lafayette, IN 47904
317-742-8428
800-742-6809

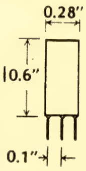
CIRCLE NO 209

How to create space on a PC Board you thought did not exist.

Now, fit 3 reed relays where only one used to fit.

Introducing the new VR 19 vertical reed relay

- Low power to operate
- Can be driven by TTL
- Can be supplied for low level switching
- 1, 2 or 4 switch models
- Form A or C relay
- Fast turnaround



Call or write for more information today!
(201) 892-5881

INRESCO

654 Ocean Rd., Point Pleasant, NJ 08742

CIRCLE NO 210

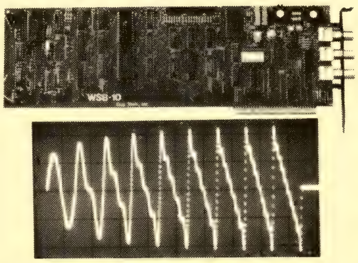
Small Space Advertising For Big Results

◆

EDN Product Mart

CIRCLE NO 211

WAVEFORM SYNTHESIZER



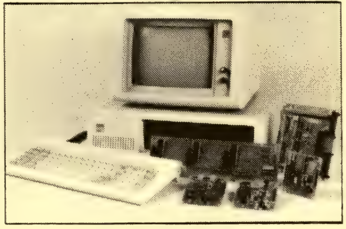
- For IBM-PC/XT/AT and compatibles
- Generates user-definable signal
- Up to 2000 points per envelope

$795.00

QUA TECH, INC.
478 E. Exchange St. Akron OH 44304
(216) 434-3154 TLX: 5101012726

CIRCLE NO 212

MODULAR DATA ACQUISITION



- For IBM & Compatibles
- Flexible and Inexpensive
- Money Back Guarantee
- Free Technical Support

Fast Delivery

QUA TECH, INC.
478 E. Exchange St. Akron OH 44304
(216) 434-3154 TLX: 5101012726

CIRCLE NO 213

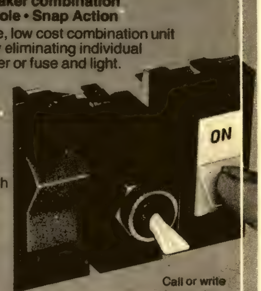
E-T-A® setting the pace for circuit protection

Quality switches with built-in dependable protection

and other approvals

Switch/Circuit breaker combination
Single or Double Pole • Snap Action

High quality, long life, low cost combination unit saves you money by eliminating individual switch, circuit breaker or fuse and light. You buy, stock, mount and wire *only one* component. High reliability of 25,000 cycles at rated load. Current ratings from 0.1A to 16A at 250 VAC. Both double and single pole units fit same small size panel cut out for single pole snap-in mounting. Variety of handle colors and styles.



Call or write for catalog

E-T-A® CIRCUIT BREAKERS
7400 N. CRONAME ROAD. CHICAGO IL 60648 • (312) 647-8303

CIRCLE NO 214

To advertise in Product Mart, call Joanne Dorian, 212/576-8015

FREE 52 PAGE CATALOG AND APPLICATIONS GUIDE

AFFORDABLE ENGINEERING SOFTWARE

CP/M
MSDOS

TRSDOS
PCDOS

PDP — Plotter Driver Program For multi and single pen plotters	$72.95
XFER — Transfer Function Synthesis Transfer functions/ Electronic circuits	$72.95
TEKCALC — Scientific Calculator Program Screen graphics/ Statistics/ Programmable	$72.95
COMCALC — Communications Design Spreadsheet Communications budget calculator	$72.95
RIGHTWRITER — Report Proofreader Program Version 2 — Applies 2,200 rules of English	$97.95

ACNAP — AC Network Analysis	$72.95
DCNAP — DC Network Analysis	$72.95
SPP — Signal Processing Program	$72.95
PLOTPRO — Scientific Graph Printing	$72.95
PCPLOT — High Resolution Graphics	$72.95
LOCIPRO — Root Locus Analysis	$72.95
ACTFIL — Active Filter Design	$72.95
STAP— Static Thermal Analysis	$72.95
MATRIC MAGIC — Matrix Manipulation	$72.95

BV Engineering
Professional Software
VISA
(714) 781-0252
2200 Business Way, Suite 207, Riverside, CA 92501 U.S.A.

CIRCLE NO 215

C CROSS-COMPILERS
MACRO CROSS-ASSEMBLERS

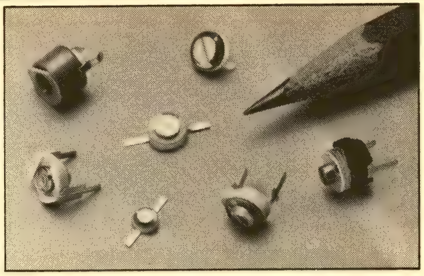
VAX **PDP-11** **IBM PC**

6801/6301	**68HC11**
6805	**68000/10**
6809	**68020**

VAX, PDP-11: TM of Digital Equip. Corp.
IBM: TM of Int'l. Business Machines

INTROL CORPORATION
647 W. Virginia St.
Milwaukee, WI 53204
(414) 276-2937

CIRCLE NO 216



Sprague-Goodman. The world's largest selection of 5mm (or smaller) trimmer capacitors.

The most wanted features found in various models include high stability, low cost, very small size, and very high Q at high frequency.

Sprague-Goodman Electronics, Inc.
SPRAGUE GOODMAN
(An affiliate of the Sprague Electric Company)
134 Fulton Ave., Garden City Park, NY 11040
516-746-1385 • TLX: 14-4533

CIRCLE NO 217

Introduce new products and literature

◆

Build awareness in the marketplace

◆

Supplement your advertising campaign

◆

EDN Product Mart

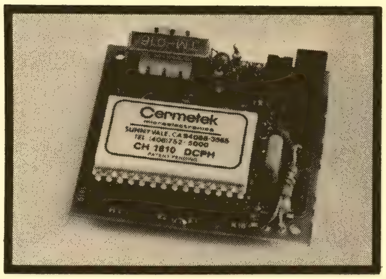
CIRCLE NO 218

REGISTERED INTEGRAL MODEM CH17L60

Easily integrated into your printed circuit design. This CMOS 212A module is FCC part 68 registered. Its powerful command set can auto-dial; auto-answer; detect dial, busy, ringback tones and run comprehensive diagnostic tests.

Cermetek Microelectronics, Inc.
1308 Borregas Avenue
Sunnyvale, CA 94088-3565
408/752-5055

CIRCLE NO 219



TELEPHONE LINE INTERFACE CH1810

Cermetek's DAA module, the CH1810, allows you to implement a REGISTERED phone line interface right on your circuit card. Be QUICK TO MARKET with your ingenious new idea without tripping over FCC hurdles.

Cermetek Microelectronics, Inc.
1308 Borregas Avenue
Sunnyvale, CA 94088-3565
408/752-5055

CIRCLE NO 220

8051

8048

SIMULATORS - CROSS ASSEMBLERS - PROGRAMMERS - SIM51 and **SIM48** Software Simulators run on IBM-PC, CP/M-80, MS-DOS. Designed for validation & debugging application software. Simulation includes all on chip functions plus expansion chips. $250, one year **FREE** updates. Formats: PC-DOS 2.x DSDD, CP/M-80 8" SSSD, many 5¼" formats. Cross Assemblers and EPROM pgmrs also available. **Logical Systems Corp.** 6184 Teall Station, Syr., NY 13217 (315) 478-0722

Logical Systems

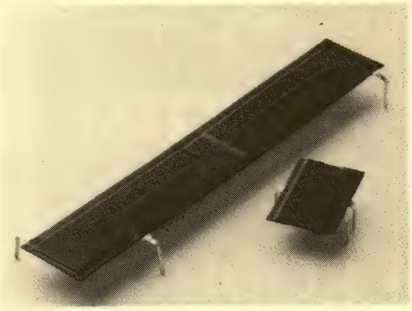
CIRCLE NO 221

The Pulse of Dependable Communications

Crystek Crystals offers their new 16 page free catalog of crystals and oscillators. Offering state of the art crystal components manufactured by the latest automated technology. Custom designed or "off the shelf," Crystek meets the need, worldwide. Write or call today!

CRYSTEK CRYSTALS
1000 Crystal Dr. • Ft. Myers, FL 33907
P.O. Box 06135 • Ft. Myers, FL 33906-6135
TOLL FREE 1-800-237-3061

CIRCLE NO 222

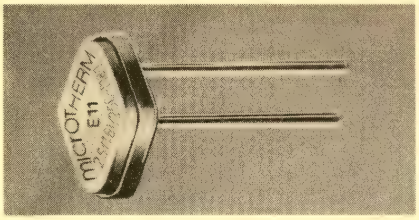


SOLVE DECOUPLING PROBLEMS

MICRO/Q capacitors with special pinout configurations give superior noise suppression, design ease. Solve special decoupling, routing problems for 8-, 16-, or 32-bit microprocessors, ECL devices, and many other devices where power and ground are not at conventional positions. **Rogers Corp.**, 2400 S. Roosevelt St., Tempe, AZ 85282. 602/967-0624

CIRCLE NO 223

To advertise in Product Mart, call Joanne Dorian, 212/576-8015



NEW, FIRST TIME OFFER
MICROTHERM'S PCB READY E11/G800

- Solid leads included
- ±3°C tolerance
- +50°C to +180°C range
- N/O or N/C in circuit
- Current sensitive
- Compact dimensions
- Rapid response
- Stainless steel housing
- <60mΩ contact resistance
- Dielectric strength 4000V_{eff}

Canadian Thermostats & Control Devices Ltd.
8415 Mountain Sights Avenue
Montreal, Quebec
H4P 2B8
(514) 739-3274

CIRCLE NO 224

Schematic Capture
$495

Now a complete design tool for your **IBM** or compatible computer that includes everything you need to design, edit, and print electronic schematics. **Compare** these features and you will discover that **OrCAD/SDT** is the most powerful, complete, and cost effective schematic design tool available.

- Full color & monochrome graphics.
- Supports A through E size sheets.
- Unlimited level hierarchy.
- Powerful keyboard macros.
- Automatic panning.
- Part rotation & mirroring.
- Utility programs for post processing.
- Over 1600 library parts.
- Supports the most common PC graphic boards, printers and plotters.

BROCHURE and DEMO DISK — NO CHARGE!

OrCAD Systems Corporation
1049 S.W. Baseline Street Suite 500
Hillsboro, Oregon 97123
(503) 640-5007

CIRCLE NO 225

Need reed proximity switches? Count on Inresco.

Key features of Inresco Sensareed™ series:

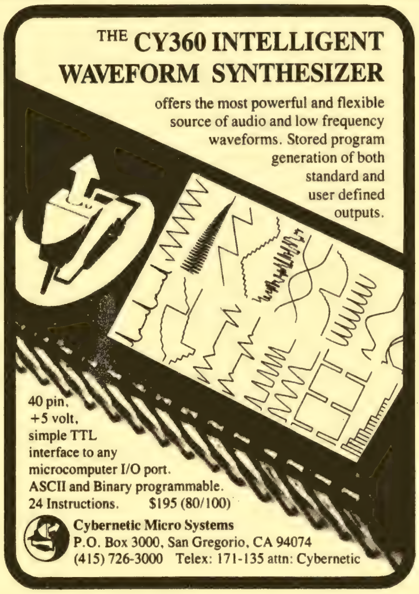
- Used in wide variety of position sensing applications
- Available in tubular and rectangular packages
- Matching magnets supplied
- Available in either Form A (SPST) or Form C (SPDT)
- Best selection in industry of power ratings, sizes and sensitivities
- Small differential between ON and OFF positions
- Other sensitivities or different packages can be supplied to meet specific application requirements

Call today for more information.
(201) 892-5881

INRESCO

654 Ocean Road, Point Pleasant, NJ 08742

CIRCLE NO 226



THE CY360 INTELLIGENT WAVEFORM SYNTHESIZER

offers the most powerful and flexible source of audio and low frequency waveforms. Stored program generation of both standard and user defined outputs.

40 pin,
+5 volt,
simple TTL
interface to any
microcomputer I/O port.
ASCII and Binary programmable.
24 Instructions. $195 (80/100)

Cybernetic Micro Systems
P.O. Box 3000, San Gregorio, CA 94074
(415) 726-3000 Telex: 171-135 attn: Cybernetic

CIRCLE NO 227

CADD for $99.95

GENERIC CADD is a sophisticated & easy to use Computer Aided Drafting/Design program for PCs.

GENERIC CADD Features:

Drawing Layers • Component Libraries
Component Libraries • User-Defined Fonts
Video & Digitizer Menus • Color Graphics

Other Available GENERIC Software:

AUTOCAD™ file conversion for $24.95
Dot Matrix printer/plotter option for $24.95

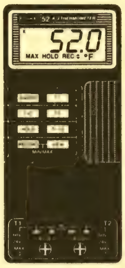
Call **1-800-228-3601** to order
No dealer calls, please.

MC, VISA, COD. Add $3.00 for shipping
60 day money back guarantee

GENERIC SOFTWARE
13250 NE 40th St.
Bellevue, WA 98005
(206) 885-5307

CIRCLE NO 228

World's smallest scanning thermometer.



Fluke 52

- Accepts two K/J-type thermocouples.
- Scans both inputs and their difference.
- Min-max recording.
- Rugged.
- 3-year warranty.

FLUKE®

John Fluke Mfg. Co., Inc., P.O. Box C9090, M/S 250C, Everett, WA 98206, Toll-free: **1-800-227-3800** ext. 229.
© Copyright 1986, John Fluke Mfg. Co., Inc., Ad No. 4704-50.

CIRCLE NO 229

ADVERTISE IN PRODUCT MART AT LOW COST

Fill out this form to advertise in Product Mart.

ISSUE(S) REQUESTED ____________________

RATE:	**1x**	**4x**	**7x**	**13x**	**19x**	**26x**	**39x**	**52x**
(Please circle)	$725	700	680	615	595	585	575	555

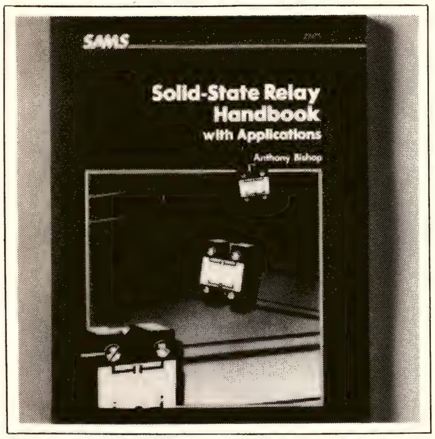
Company ____________________
Address ____________________
City ____________________ State__________ Zip __________
Telephone ____________________
Signature ____________________

AD ENCLOSED ☐ AD TO FOLLOW ☐

Mail to: EDN / 275 Washington Street / Newton, MA 02158-1630

EDN PRODUCT MART appears in every issue — 26x a year!

To advertise in Product Mart, call Joanne Dorian, 212/576-8015

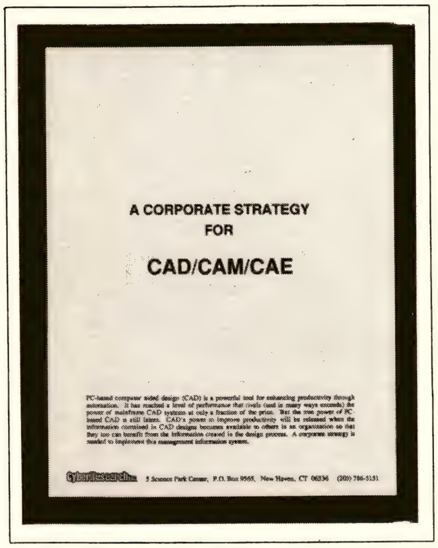


Guide to relays

Solid-State Relay Handbook with Applications is a compendium of data on solid-state relays: what they are, how they work, and how to select, specify, test, and apply them. The 250-pg, softbound book includes some suggested drive and protective methods and includes application notes. $19.95.

Howard W Sams & Co, Dept R22, 4300 W 62nd St, Indianapolis, IN 46268.

INQUIRE DIRECT



Report examines CAD/CAM/CAE

A Corporate Strategy for CAD/CAM/CAE describes how you can integrate an engineering CAD system into a corporate information system to improve productivity in manufacturing, marketing, and management/engineering functions within a company. The 14-pg report provides details on choosing the appropriate personal computer hardware and software for workstations in all departments to facilitate easy data transfer. The report comprises three sections: One section presents an overall strategy for integrating CAD/CAM/CAE into a corporate information system; another describes pc-based CAD information systems, and the third provides examples of pc CAD information-system workstations.

CyberResearch Inc, Box 9565, New Haven, CT 06536.

Circle No 413

Catalog condenses modem data

This condensed product catalog covers the Express Data family of 1200- to 2400-bps micro-to-mainframe modems and modem racks. In addition, it includes an insert on the 300/1200/2400-bps PoneExpress and 9600-bps IBM PC (and compatible) versions. It includes summaries on integral single-slot cards, half cards for short slots, stand-alone modems compatible with any computer, and 16-slot modem racks with built-in power supplies. Finally, the catalog explains about the company's toll-free number, which provides for automatic remote diagnostics and instant warranty activation on all installed modems.

Telenetics Corp, 895 E Yorba Linda Blvd, Placentia, CA 92670.

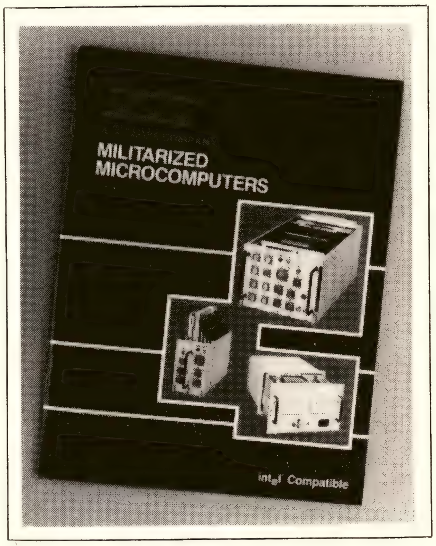
Circle No 414

Compilation of seminars

This booklet covers seminars that a consulting company has scheduled through August. It details seminars, symposiums, and conferences on fourth-generation software technologies, applications development, artificial intelligence, database technologies and implementation, end-user computing, communications, and microcomputer software. This year's proposed schedule includes five new seminars: "Implementing DB2," "Data Communications: The Fundamentals of Network Design," "Successfully Using and Managing Your IBM PC XT/AT," "Strategic Data Planning: Developing the Blueprint for Database Design," and "Distributed Database: How to Integrate Data in a Multi-Vendor Environment."

Digital Consulting Associates Inc, 6 Windsor St, Andover, MA 01810.

Circle No 415



Catalog highlights militarized microcomputers

This 28-pg catalog touches upon the vendor's line of 8- and 16-bit Intel-based μCs that include the hardware required to satisfy military environments. The brochure highlights the features of such products as CPU modules, memory modules, I/O modules, analog modules, peripheral controllers, and power supplies. In addition, it contains a product-selection guide, including such characteristics as power requirements, software support, parallel and serial I/O, and transfer rate. One page of the catalog is devoted to descriptions of new products in development.

Severe Environment Systems Co, Box 2668, Chatsworth, CA 91313.

Circle No 416

8-bit crossassembler adapts to many instruction sets

***Cross-8,** Universal Cross-Assemblers, Box 384, Halifax, Nova Scotia, Canada B4A 2X3. $99.95 (US), $129.95 (Canada).*

If you've ever needed to develop programs for a variety of 8-bit µPs, you may have discovered that buying a new assembler for each device can be costly in both time and money. Assembler prices vary from tens to hundreds of dollars, and each vendor has a unique user interface and syntax that you must learn. The Cross-8 universal crossassembler offers a unified syntax and the ability to assemble source code for almost any 8-bit µP. Cross-8 runs on an IBM PC or CP/M system, including Apple IIs with CP/M-80 softcards. All versions cost $99.95 (US).

At the heart of the Cross-8 package is a 24k-byte, table-driven assembler. You can develop instruction tables using directions in the 36-pg manual, or you can use one of the tables supplied with the assembler. Tables are supplied for the 1802, 3870, 6502, 6801, 6805, 8048, 8051, 8085, COP400, Z8, and Z80 µPs and families. A 6809 table is supplied only on the MS-DOS version because it's approximately 30k bytes long.

Each table is an ASCII text file containing descriptions of the various instructions and registers for one µP or family. For example, an 8080 MOV instruction is defined in the table by the line

```
MOV{2B3},{5B3}^B0:.
```

MOV designates the op-code mnemonic. The first operand (the destination) is defined by the characters 2B3 enclosed by the first set of braces. The number 2 indicates the starting bit position within the op code for the first operand, and the number 3 gives the operand's size in bits. Bit positions are numbered from 0 to 47 and start at the leftmost bit of the op code. The B is the operand type; type B requires Cross-8 to perform a logical OR operation using the op code and operand as arguments, and to perform range checking on the operand. Cross-8 has seven operand types covering most of the requirements for 8-bit µPs.

You use your word processor or text editor to create new tables or modify existing ones. The supplied tables (excluding the 6809) range from about 500 to 3k bytes, so table creation appears to be a fairly simple task. A utility called CRS8SORT supplied with the assembler sorts instructions alphabetically and checks for table-syntax errors.

Because you define the syntax for instructions, operands, and operand

High Resolution, Low Price!

86,400 counts/rev* (1 count = 15 arc seconds) .... under $410**

216,000 counts/rev* (1 count = 6 arc seconds) .... under $690**

432,000 counts/rev* (1 count = 3 arc seconds) .... under $1035**

*counts/rev after quadrature edge detection; many other resolutions available

**price is for quantity 1-10 and depends on resolution, output and housing options—significant discounts available for higher quantities

TELEDYNE GURLEY
514 Fulton Street P.O. Box 88 Troy, NY 12181-0088
(518) 272-6300 TWX (710) 443-8156

CIRCLE NO 161

ordering in the instruction tables you create or modify, you can create an assembler that matches your preferences. You may, for example, be fond of Intel's 8080 mnemonics but prefer Zilog's Z80 operand ordering. However, you must conform to Cross-8's label and pseudo-op-code syntax. Labels must end with a colon. Pseudo-op codes such as Define Byte and Equate have been defined by Universal Cross-Assemblers and are not table driven. This practice can be advantageous, because you may have difficulty remembering each manufacturer's favorite syntax for every pseudo-op code when changing assemblers.

In addition, Cross-8 has two special pseudo-op codes: CPU and HOF. The CPU pseudo-op code determines which µP instruction set will be used during assembly. CPU takes a single operand that's the name of the desired table. The HOF pseudo-op code specifies the output format of the hexadecimal file that Cross-8 produces during the assembly. The assembler can generate Intel, Motorola, and Tektronix hexadecimal object files.

There are a few desirable features you won't find in the Cross-8 package. It isn't a macroassembler. Because Cross-8 is limited to 8-bit processors, this limitation may not be a major failing. But some programmers cannot write programs without macros, and Cross-8 is not appropriate for them. The 8-bit focus is a key limitation. All operands are limited to 16 bits, as is the address range, and op codes are limited to six bytes. Consequently, there is no hope of expanding this version of Cross-8 into the 16-bit arena. For $99.95, however, you can assemble code for most 8-bit µPs and single-chip µCs, which is a lot of capability for the money.

—Steven H Leibson

NOW 8051 SUPPORTED

A COMPLETE IN-CIRCUIT EMULATOR FOR $3995!

Ziltek's low-cost ICE-ENGINE/BX-8 is the *only* real-time In-Circuit Emulator available that completely supports 8-bit microprocessor's software/hardware development. Its $3,995 price tag includes the EPROM programmer, eraser, and the pod of your choice. Additional pods are just $990 each. Check these outstanding features:
- Compatible with IBM® PC and dumb terminals.
- With appropriate pods, supports Z80™ (A,B,H), 8085, 6809, 8048 and Z80 CMOS series µPs. Additional pods available soon.
- Full symbolic debugging.
- Powerful and easy-to-use Debug Command Language.
- Single, sequential and delayed triggers.
- Unique register trace.
- More than 50 commands keep you in complete control.
- "Help" menus always available instantly.
- All other standard emulator features.

Call or write today for complete information.

ZILTEK CORPORATION
A subsidiary of Adtek System Science Co., Ltd.
1651 E. Edinger Ave., Santa Ana, CA 92705
Telephone: (714) 541-2931
FAX: (714) 541-2933

CIRCLE NO 155

OUR MODEL 370 JUST MADE THE DRV11-WA TOO SLOW AND TOO EXPENSIVE

Introducing the Model 370 from Grant Technology.

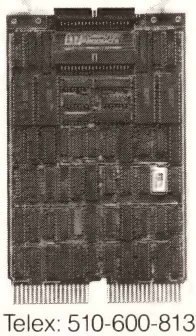
$650 QTY. 1

The Model 370 is an enhanced, high-performance replacement for the DEC DRV11-WA* DMA interface with:
- Block mode DMA for increased data transfer rates
- Optional input FIFO buffer for even greater throughput
- DRV11-WA software and diagnostics compatibility
- Q-bus* and MicroVAX II* compatibility

For more information on our extensive line of Q-bus compatible and VMEbus* products — all designed to provide more performance at lower cost — call or write: Computer Products, Grant Technology Division, 11 Summer Street, Chelmsford, MA 01824. Tel.: (617) 256-8881 or Telex: 510-600-8133.

COMPUTER PRODUCTS™
GRANT TECHNOLOGY DIVISION

*DEC, DRV11-WA, MicroVAX II and Q-bus are registered trademarks of Digital Equipment Corporation. VMEbus is a registered trademark of Motorola, Inc.

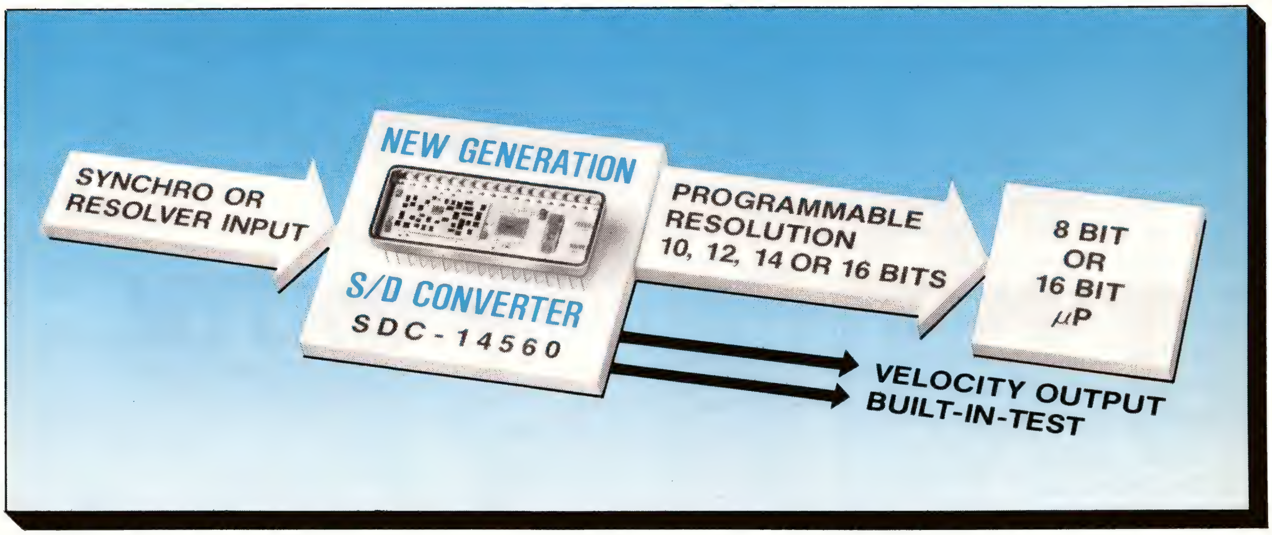
CIRCLE NO 156


DDC NEWS

ABOUT SYNCHRO-CONVERSION • HIGH-SPEED, HIGH ACCURACY D/A & A/D CONVERSION • DATA BUS DEVICES

PUBLISHED BY **ILC DATA DEVICE CORPORATION** JUNE 1986

MILITARY SYNCHRO CONVERTER OFFERS DYNAMIC PROGRAMMING



The SDC-14560 series S/D converters offer programmable resolution of 10, 12, 14, or 16 bits, tachometer-like high quality velocity output and accuracy to 1.3 arc minutes. In addition, a Built-In-Test (BIT), CT mode operation, transparent latch, and three-state output in two bytes are standard features.

The SDC-14560 was configured to provide new capabilities to system designers. Programmable resolution allows both high speed position tracking and precise positioning with one converter. Where speed is essential, 10 bit resolution allows the highest tracking rate of 160rps. Conversely, when exact positioning is required, 16 bit resolution can be dynamically selected.

Velocity output (VEL) from the SDC-14560 is a ground based voltage of 0 to ± 10VDC at the highest tracking rate for each resolution. VEL is positive for an increasing angle. Through the use of this highly characterized signal, the electro-mechanical tachometer may be eliminated from the system. The benefit is savings in system size, weight and cost.

All SDC-14560 converters provide Built-In-Test (BIT), a transparent latch and three-state output in two bytes. The BIT circuit detects over-velocity, out-of-null circuit conditions, and most converter or input failures. The three-state, two byte output and transparent latch provide for easy computer interface and continuous angle tracking while an inhibit is applied during data transfers.

Two input options are included in the SDC-14560 series: synchro or resolver. Models are offered with broadband frequency ranges of 360 to 1kHz, or 47 to 1kHz.

The SDC-14560 is a Monobrid® design which incorporates a custom LSI chip in its circuitry. Use of the LSI chip results in fewer parts, thereby increasing the reliability. The converters are packaged in a compact 36-pin DDIP measuring 1.9 x 0.78 x 0.21 inches and weigh 0.7 oz. Power requirements are ±15VDC and +5VDC supplies. Two operating temperature ranges are available: 0°C to +70°C and −55°C to +125°C.

The SDC-14560 series is designed for use in modern high performance high reliability commercial and military motion control systems. All models are available with MIL-STD-883 processing as a standard option. Some typical applications include radar, navigation and fire control systems, flight instrumentation and flight trainers or simulators.

Learn how you can improve your system designs with the new SDC-14560 from DDC. Call one of our regional offices today for all the details. ☐

® Monobrid is a registered trademark of ILC Data Device Corp.

DDC
FULLY CERTIFIED TO
MIL-STD-1772

Circle No. 8 for Sales Contact

Circle No. 47 for Literature

DDC
ILC DATA DEVICE CORPORATION

HEADQUARTERS AND MAIN PLANT: ILC Data Device Corporation, 105 Wilbur Place, Bohemia, N.Y. 11716, (516) 567-5600, TWX: 510-228-7324
WEST COAST (CALIF.): WOODLAND HILLS, (818) 992-1772, TWX: 910-499-2674; SANTA CLARA, (408) 244-0831, TLX: 172775; HUNTINGTON BEACH, (714) 840-5723
WASHINGTON, D.C. AREA: (703) 893-7989, TWX: 910-997-0967; **NORTHERN NEW JERSEY:** (201) 785-1734, TWX: 130-332
EUROPEAN OFFICE: 01-387 4599, TLX: 851-261967; **UNITED KINGDOM:** (44) 635-40158, TLX: 851-848826; **FRANCE:** (1) 4-333-5888, TLX: 842-630609
WEST GERMANY: (08191) 3105, TLX: 841-527128; **SWEDEN:** 46-8-920-635, TLX: 854-10952; **JAPAN:** (03) 490-0203, TLX: 781-34158

Software users and vendors square off over the issue of product responsibility

Richard Beutel
Washington, DC

Jon McIntosh

The software industry is the last citadel of the legal doctrine of caveat emptor, or "let the buyer beware." But that tradition is starting to crumble as software consumers make it known that they're no longer willing to assume the burden of responsibility that software license agreements place upon them. Declaring that their rights extend far beyond those contained in typical license agreements, software consumers have found support from users groups, trade associations, and state governments. Yet the real solution lies in the form of federal legislation, for which it will be difficult to find congressional support.

A *Wall Street Journal* article elicited a storm of protest from the software industry last year when it pointed out the stark contrast between licensing agreements' promises and the associated products' performance. The article cited the lavish claims made in advertisements for Lotus Development Corp's Jazz software and the disclaimer in the program's license: "Jazz may be the only software you'll ever need," the advertisements puffed, while the licensing agreement stated bluntly, "You the licensee are assuming the entire risk as to [Jazz's] quality and performance."

Industry raises the hue and cry

Software vendors responded to the article with protests. They argued that software's special nature—the fact that it's based on new technologies, and that, like works of art, it's the result of intellect and imagination—required that it be sold strictly "as is" with no guarantee of any kind. End users, on the other hand, pointed out that software vendors, unlike vendors of other consumer products, typically require consumers to assume nearly all of the risk for their product's performance.

Software makers' claims of special privilege began losing their sway with consumers once the manufacturers began to mass-market their products. When software reached the mass market, it was purchased by consumers who were much less willing to accept the traditional burden of responsibility that software makers had always placed on customers. As software became a commodity-like product, it lost its aura of specialty. Corporate software consumers, in particular, lost patience with software makers' demands, as is evident in the spate of lawsuits that disgruntled companies have filed against the manufacturers.

Consumers have found assistance in their plight on several fronts. Several state legislatures have undertaken to strengthen software buyers' rights through consumer-protection laws. Proposed legislation in California would transform the puffery of computer advertisements into warranties binding upon software developers. The same bill also limits warranty disclaimers and provides an implied warranty of fitness on the sale or lease of new computer products or parts. Similar bills are also pending in the Florida, New York, Rhode Island, and Wisconsin legislatures. Software vendors, seeing the bills' provisions as imposing too much responsibility on themselves, have lobbied aggressively against the legislation.

The state legislatures of Louisiana and Illinois recently passed bills that regulate the claims that can be made in shrink-wrap licenses. A shrink-wrap license is

---

©1986 Richard Beutel

an attempt to bind a consumer to an extensive list of responsibilities and prohibitions upon the mere opening of the software package. These licenses generally prohibit users from copying, disassembling, decompiling, modifying, or tampering with the software. Lawyers who specialize in software issues seriously dispute the validity of such licenses.

Users groups and trade associations have also turned their attention to balancing responsibility for software products between consumers and vendors. In Washington, DC, the Capitol IBM PC Users Group, one of the nation's largest users groups with a membership approaching 4000, issued a "Users' Bill of Rights" that has gained widespread attention. Among the document's assertions are consumers' rights to products that conform to industry standards and meet advertising claims. In addition, the group backs consumers' rights to continuous service and support from vendors.

Without the protection afforded by a software users' bill of rights, relations between software vendors and users will most likely continue to deteriorate.

The group also supports users' rights to integrate their software into existing configurations without the hindrance of copy-protection schemes, software authorization requirements, or other extraneous functions. The right to systems integration is controversial because it conflicts with vendors' interests in protecting their software from piracy—an interest directly related to sales revenue. However, with the increasingly widespread use of site licensing—a contractual agreement that gives additional copies of the program at a flat rate—the concerns of software vendors regarding software piracy may diminish.

Industry representatives have also acknowledged the serious deterioration of relations between software vendors and end users and have taken steps to ease the strain. One trade group, the Software Publishers Association (Washington, DC), has embraced the concept of a bill of rights for end users by publishing voluntary guidelines for software vendors and users. The Association for Data Processing Service Organizations (Adapso), based in Arlington, VA, has formed a committee of vendors and users to lower tensions and conduct research into solutions to the problems.

A morass of legislative solutions

Without the protections afforded by a bill of rights, relations between software vendors and end users will most likely continue to deteriorate. An escalation of litigation by disgruntled data-processing managers and corporate end users against software companies is possible. Though this scenario may bode well for the lawyers, anyone truly committed to the long-term success of the software industry will recognize how unhealthy the situation is becoming.

Private sector and state efforts solve only part of the problem, and the need for federal legislation is readily apparent. The differing state laws will eventually produce a patchwork of disparate commercial environments that present a genuine risk to the continued health and vitality of the software industry. Only by enacting uniform, federal legislation can this problem be effectively addressed. Consumer-protection legislation, however, is traditionally governed by state laws, and convincing federal legislators to tackle the issue of software users' rights won't be easy. The legislative history of the United States is replete with protracted struggles regarding state vs federal jurisdiction. Even so, the Capitol IBM PC Users Group, using the tenets contained in its proposed bill of rights, has begun lobbying Congress to gather support for federal regulations.

Opponents of consumer-protection legislation for software end users argue that government regulation is not needed. The Pandora's box of regulation, however, has already been opened. The movement in state legislatures to impose additional consumer protections upon the software industry is rapidly gaining momentum. Now is the time for an end users' bill of rights to become law, but it should be enacted at the federal level, where it can uniformly and equitably balance the allocation of commercial risk in a dynamic and exploding industry. **EDN**

Author's biography

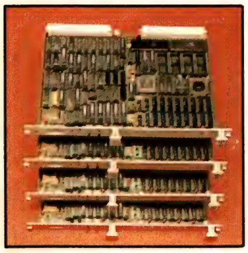
Richard Beutel is an attorney with Abrams, Westermeier, and Goldberg, a Washington, DC computer-law firm specializing in software law. He formerly practiced law for two years in California's Silicon Valley region. He earned his JD from Georgetown University Law Center (Washington, DC) and his BA from Pomona College (Claremont, CA).

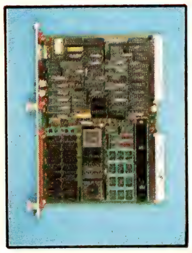
Section Interest Quotient (Circle One)
High 518 Medium 519 Low 520

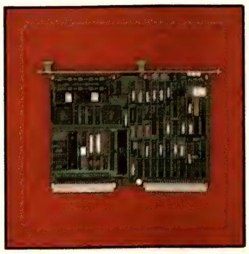
THE HI-PERFORMANCE PEOPLE **ELECTRONIC MODULAR SYSTEMS INC.**

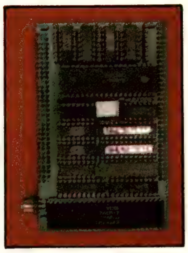
VMEbus Central Processors

REAL TIME APPLICATIONS


CPU-2RT


CPU-2SC

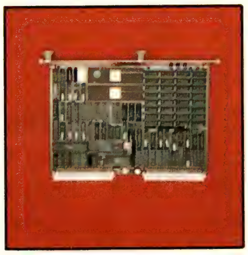

CPU-2PB

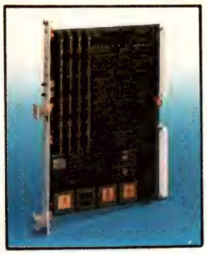

PIGGY BACK BOARDS

68020
@ 12.5 MHz,
16.5 MHz, or
20 MHz,
DRAM ¼ Mb,
1 Mb, or 4 Mb

CPU-4RT

STAND ALONE HOST


CPU-1


CPU-3

	STAND ALONE HOST		REAL-TIME MASTER/SLAVE			
	CPU-1	CPU-3	CPU-2RT	CPU-2SC	CPU-2PB	CPU-4RT
MICROPROCESSOR	68000/68010	68010	68000/68010	68000/68010	68000/68010	68020
FREQUENCY	8MHz	12.5 MHz	12.5 MHz	12.5 MHz	12.5 MHz	12.5 - 20 MHz
MEMORY MANAGEMENT	68451	68451 (2nd as option)				
DMA	LOGIC		68450 option	68450 option	68450 option	
FLOATING POINT PROCESSOR		68881 (option)			68881 (option)	68881 (option)
RAM (DUAL PORTED)	256 Kb	2 Mb	128/512 Kb	128/512 Kb	512 Kb	1/4, 1, 4 Mb
EPROM		2 Sockets (128 Kb)	2 Sockets (128 Kb)	2 Sockets (128 Kb)	2 Sockets (128 Kb)	2 Sockets (128 Kb)
EEPROM			2 Sockets (16 Kb)	2 Sockets (16 Kb)		
SIO	1 PORT	1 PORT	2 PORTS	4 PORTS	• I/O ON PIGGYBACK BOARDS • PB-SCSI1 SCSI/DMA • PROTO BD	3 PORTS
PIO	1 PORT		1 PORT			
TIMERS	1	4/ 8 bit	3/ 16 bit			1/ 32 bit
ADDITIONAL FEATURES	1K PROM FLOPPY DISK CONTROLLER	Translation Cache	R/T CLOCK 58274	R/T CLOCK 58274		
SOFTWARE	UNIX* SYS V	UNIX* SYS V pSOS**	pSOS** PDOS***	pSOS**	pSOS**	pSOS** PDOS***

ONE YEAR WARRANTY

*UNIX is a trademark of AT&T Bell Laboratories

**pSOS is a trademark of Software Components Group

***pDOS is a trademark of Eyring Research

ELECTRONIC MODULAR SYSTEMS INC.

USA
Electronic Modular Systems, Inc.
4546 Beltway
Dallas, TX 75244
214/392-3473
Telex: 791688 Pasadena Dal

EUROPE
Electronic Modular Systems, GmbH
Robert-Koch Str. 1-3
6078 Neu-Isenburg
West Germany
06102/3117
Telex: 841/4185633 EMS D

UK
Electronic Modular Systems, Ltd.
Bray House Martin Road
Cordwallis Ind. Estate
Maiden Head, Berks S167DE England
0628/76062
Telex: 851/846369 Bray G

INDIA
Pasadena Technology India, Ltd.
10 Jawahar Road, Chokkikulam
Madurai 625-002 India
0452/41616
Telex: 953/445-320 SCT IN

A Subsidiary of Pasadena Technology Corporation

CIRCLE NO 153

Engineering

HIGH TECHNOLOGY IN A DOWN-TO-EARTH ENVIRONMENT

COMARCO is a fast-growing high technology company, continuing to expand its role in engineering and technical support of the U.S. Naval Weapons Center at China Lake, California. The NWC is a unique resource serving as the Navy's principal installation for missile weapons systems research.

Comarco's extremely high level of technical expertise includes evaluating weapons systems, performing logistics documentation, developing test procurement specifications and providing independent software verification and validation and a variety of other supportive activities.

If you have experience in the applications of military standards, an A.S., B.S. Degree or higher, from 2 to 15 years experience, and U.S. citizenship, consider the following openings:

- **RELIABILITY ENGINEERS**
- **SYSTEMS SAFETY ENGINEERS**
- **SENIOR ENGINEERS (COMPUTER SYSTEMS & SOFTWARE)**
- **MECHANICAL ENGINEER, STRESS ANALYSIS**
- **RADAR MISSILE SYSTEMS ENGINEER**
- **ENGINEER, ILS**
- **QUALITY ASSURANCE ENGINEERS**
- **SOLDERING TECHNOLOGY INSTRUCTORS**
- **ENGINEERING TECH / SR. ENGINEER INSTRUMENTATION & EMC**
- **ELECTRONIC ENGINEER / CIRCUIT DESIGN / TEST EQUIPMENT**
- **SENIOR DRAFTER / CAD / COMPUTER-VISION**
- **ENGINEERING WRITER (SPECIFICATIONS)**

Surrounded by the great outdoors, yet only 150 miles from Los Angeles, the China Lake area is a down-to-earth small town environment that has a lot to offer in terms of affordable housing, clean air and a lifestyle away from the crowded cities. The sports enthusiast will find plentiful hunting, fishing, skiing and boating opportunities only minutes away.

Comarco offers a variety of challenging and professionally rewarding assignments combined with excellent salaries and a benefits package that includes relocation allowance, profit sharing, stock ownership and more. For high technology in a down-to-earth environment, send your resume including salary history to:

COMARCO

COMARCO Weapons Support Division
1201 N. China Lake Blvd., Dept. EDN626,
Ridgecrest, CA 93555
Attention: Employee Relations

An Equal Opportunity Employer M/F/H/V

CAREER OPPORTUNITIES

1986 Editorial Calendar/Planning Guide

EDN

EDN CareerNews

Issue Date	Recruitment Deadline	Editorial Emphasis	EDN CareerNews
July 24	July 2	Product Showcase—Volume II; Computers & Peripherals; Components; Test & Measurement Instruments; International Products; Literature on ICs & Semiconductors, Hardware & Interconnection Devices, Power Supplies/Sources, Software	
Aug. 7	July 17	Resistors; CAE; Communications ICs; Microprocessor Development Software; Technical Article Database Index	Closing: 8/14 Mailing: 8/26
Aug. 21	July 31	Military Electronics Special Issue; High-speed ICs; Communications Technology	
Sept. 4	Aug. 14	Test & Measurement Special Issue; Oscilloscopes; Automated Design & Engineering for Electronics Product Preview (CAE-related*); Meters; Display Technology	

Call today for information.
East Coast Janet O. Penn (212) 576-8049
West Coast Dan Brink (714) 851-9422
National Roberta Renard (212) 576-8048

NATIONAL SALES MANAGER — COMPUTER BASED INSTRUMENTS

Help drive the continued growth of Heath Company. We are a highly successful leader in the manufacture of microcomputers and electronic kits with the full support of Zenith Electronics Corporation. We currently seek a National Sales Manager.

The primary responsibility for this position is to establish and maintain a national network of independent sales representatives. You will work in close relationship with our product line managers and marketing managers while directing, training and recruiting sales representatives.

Qualified candidates must have 2-3 years of sales management experience in the field of electronic instrumentation with national exposure. A Business/Marketing degree, and a background in selling electronics to end users also necessary.

Located in an attractive lakeside community, Heath/Zenith offers competitive salaries, comprehensive benefits, and advancement opportunities. For consideration, send resume or call: Bill Flowers.

HEATH COMPANY
A Wholly Owned Subsidiary Of
Zenith Electronics Corporation
Hilltop Road
St. Joseph, MI 49085
616/982-3504
An Equal Opportunity Employer M/F/H/V

HEATH
ZENITH ®

Grand theft in Seaford, L.I. Long Island is great for kids. In fact, a national publication ranks it one of the best places to live in the U.S. And for engineers, only Grumman offers so many career choices here. So send your resume in confidence to Employment Manager, Mail Station C07-GHQ, Grumman Corporation, Bethpage, Long Island, NY 11714-3586.

Only GRUMMAN.

GRUMMAN®

® A registered trademark of Grumman Corporation.
Grumman Corporation is an equal opportunity employer. U.S. citizenship required.

Winning Moves

There is one area in electronics where you consistently find winners. Communications. It is the place to be when you want a myriad of job opportunities and the excitement of technological frontiers. If you have a background in . . .

Data Communications
Signal/Voice Processing
SNA/SDLC
ASYNC/BISYNC
Microwave/RF/Antenna
CICS, TSO, IMS
C^3/C^3I

Local Area Networks
  - STAR, RING, BUS
  - CSMA/CD, Tokenpassing
  - Baseband/Broadband
  - ETHERNET/DECNET
Halfduplex/Fullduplex
IBM 370, 30XX, 43XX

Telecommunications
Access Methods
Satellite Communications
Multipoint/Point to Point
Network Architecture
  - Switched/CS, PS, MS
  - Nonswitched

. . . experience intellectual fulfillment, security, and the rewards you deserve. With employment openings across the country, we can help you make a winning move in Communications.

Call Ron Stearn collect **(617) 246-4444** or submit resume to:

Computer Science & Engineering
12 Lakeside Office Park, Wakefield, Massachusetts 01880

Client companies assume all fees

LET US PLACE YOU IN A BETTER JOB NOW

Put our 20 years experience placing technical professionals to work for you. Client companies pay all fees; you get our expert advice and counsel FREE. Nationwide opportunities in Communications, Defense, Intelligence, Computer, Satellites and Aerospace Systems. If you earn over $25,000, we have a better, more rewarding job for you . . . right now. U.S. Citizenship is required. EBI/SBI desirable. Send your resume in confidence to: Dept. EA-ECN.

WALLACH associates, inc.

Washington Science Center
6101 Executive Boulevard, Box 6016
Rockville, Maryland 20850-0616

Technical and Executive Search

Wallach . . . Your Career Connection

ENGINEERING

Many opportunities in Telecom, CO, Cellular, RF, CAD, I & C, Computers, Peripherals, Engineering Management. Send resume to:

MTI
20287 N. Hwy 21
Suite 104
Wheeling, IL 60090
Noel Rice 312/541-6440

Go out of your mind.

At Cipher Data we encourage the innovator. We value the visionary. We respect the maverick.

It's not our style to stifle the creative engineering it takes to stay on top of today's demanding and exciting computer industry, and to continue to develop and manufacture the superior removable storage hardware and related peripheral products we're known for.

Our philosophy is to take an elite team of talented engineers, furnish them with unsurpassed facilities and equipment, and provide them with challenging and ambitious projects.

We currently have the following opportunities available:

- **READ/WRITE TAPE HEAD ENGINEER**
- **READ/WRITE CIRCUIT DESIGN ENGINEERS**
- **QUALITY TAPE HEAD ENGINEER**
- **TEST ENGINEERING MANAGER**
- **SERVO ENGINEERS**
- **MICROCODERS**
- **PRINCIPAL LSI DESIGNER**

Enjoy the freedom to go beyond the conventional with your engineering expertise. Go out of your mind with Cipher Data.

Interested candidates please send your resume to: Duane Trombly, Professional Staffing, Dept. 070, Cipher Data Products, Inc., P.O. Box 85170, San Diego, CA 92138. EOE M/F/H/V

cipher® data products, inc.

EDN Recruitment

Roberta Renard
National Sales
Manager
(212) 576-8048

Janet O. Penn
East Coast
Manager
(212) 576-8049

Dan Brink
West Coast
Manager
(714) 851-9422

Have your horizons shrunk?

If you're facing limited possibilities in your present job, you could make a new beginning at General Dynamics Data Systems Division. We provide data systems and computer services support for the entire General Dynamics company in such areas as aerospace, information systems, land systems, shipbuilding and electronics. So there are opportunities in all directions. Plus excellent salaries and benefits.

To explore new horizons in *PRODUCT SOFTWARE, CAD/CAM* and *ENGINEERING SYSTEMS,* send your resume to Vice President and Center Director at the Data Center of your choice.

And expand your world again.

Western Center
P.O. Box 85808, MZV2-5150
Drawer 039
San Diego, CA 92138

Central Center
P.O. Box 748, MZ5304
Drawer 039
Fort Worth, TX 76101

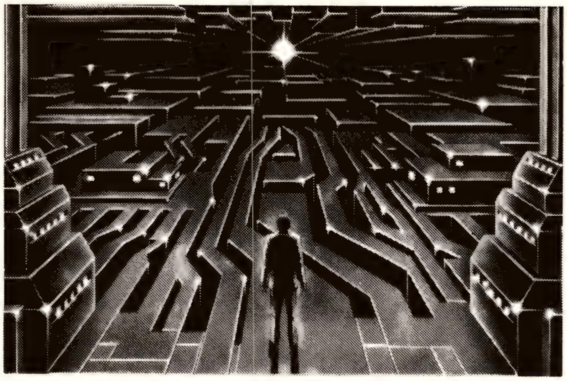
Eastern Center
100 Winnenden Road
Drawer 039
Norwich, CT 06360

GENERAL DYNAMICS

Data Systems Division

Equal Opportunity Employer/U.S. Citizenship Required

Intel...



Changing Technological Horizons Again!

The ability to adapt quickly to rapid changes in both market and technology is the mark of an Intel professional. As a result, we have contributed to a number of "firsts" in the microelectronics industry. Now we're setting industry standards for single board computers and supermicro systems...and the process of innovation goes on. We still place a high premium on finding people who have inquiring minds, strong technical skills, and the ability to adapt quickly to changing situations. If you have experience in any of the areas below and want to see your work integrated into sophisticated new products, let's talk!

SYSTOLIC ARRAY MICROPROCESSOR DEVELOPMENT GROUP

Architecture Designer ★

Language Compiler Designer ★

SEMICUSTOM GROUP

Software CAD Engineers ● ►
  Performance Verification Electromigration
  Workstation Developers
  Silicon Generation Automatic Place & Route
  Circuit Simulation
  Software QA
  Data Base Management Systems
  Test & Fault Grading

Design Center Manager ●

Design Engineers/Managers ● ►
  Logic Designers
  Circuit Designers

Technical Writers ● ►

Marketing Engineers ● ►
  Customer Marketing
  Product Marketing
  Applications

Process Equipment Engineers ● ►

Software/Test Engineers ● ►

Product Engineers ● ►

Process Engineers/Managers ● ►
  Thin Films
  Plasma
  Device
  Computer Integrated Manufacturing (CIM)

Fab Training Manager ●

Quality & Reliability Program Managers ● ►

ADVANCED MICROPROCESSOR DEVELOPMENT GROUP

VLSI CMOS Component Designer ★

Senior Test Engineer ★

Senior Product Engineer ★

SYSTEMS GROUP

Quality Assurance Engineer ★

Sr. Product Public Relations Specialist ►

Software Evaluation Engineers ►

Programmer/Analysts ►

Systems Support Engineers ►

LAN Software Engineers ►

IBM Control Unit Engineers ►

IBM Systems Programmers ►

Project leaders and individual contributor positions available. All positions require 3 + years experience with an MS/PhD in EE or CS. For details, call our Employment Rep at the Intel site of your choice. If unable to call, please send your resume in confidence to the address listed. An Equal Opportunity Employer M/F/H.

● **Intel Santa Clara, Dept. 295805, P.O.Box 58121, Santa Clara, CA 95052-8121. Attn: Pam Najera (408)496-7551.**

► **Intel Arizona, Dept. 295805, 5000 W. Chandler Blvd., Chandler, AZ 85226. Attn: Mike Gore (602)961-5794, or Chris Kumlin (602) 869-4246**

★ **Intel Oregon, Dept. 295805, 5200 NE Elam Young Parkway, Hillsboro, OR 97124-6497. Attn: Eileen Schneider (503)681-4597.**

intel®

59 PM ALT 24160 MSN 02 SRT 07 RUN 05 DAT

Radar Imaging. Goodyear capability stretches your ability.

The Arizona Division of Goodyear Aerospace has developed airborne synthetic-aperture radar systems to provide military commanders with a valuable reconnaissance tool. New systems now pierce adverse weather and darkness for round-the-clock reconnaissance. Moreover, air-to-ground data link and unique processing interpretation equipment deliver the intelligence yield to commanders within minutes. Goodyear Aerospace has the experience—plus the projects—to stretch your technical proficiency.

Engineer Sr. Development

Digital Systems or Signal Processing

Experience in high-speed digital logic design, familiarity with TTL, CMOS and ECL. Experienced with digital filtering techniques and digital systems. Will originate design of digital systems from functional descriptions.

Engineer Development

Microwave

Development and application of waveguide components, coaxial devices and solid state RF circuits for airborne military radar, from VHF to millimeter waves. Digital control and antenna experience.

Engineer Sr. Development

Radar Systems Design & Analysis

Generate system requirements and specifications for advanced radars, originate system concepts and analyze radar system problems. Includes systems integration, systems analysis, hardware design, fabrication, qualification and acceptance testing. Formulate and coordinate technical plans from conception to system development.

Systems Engineers

Radar Systems

Generate system definition and specifications based upon the application requirements, customer specifications, and applicable MIL SPECS; perform system modeling, error analysis, error budgeting, and signal trace analysis; generate formal and informal documentation; make formal and informal presentations of technical material; and interface with customer, associate contractors and subcontractors on technical issues.

Systems Project Engineer

Knowledge of flow down requirements from customer requirements to design specifications. Ability to accomplish systems definition ie. define systems architectures for image/intelligence display systems. Ability to establish and direct trade studies, analyze technical requirements and select the best approach methodology. Knowledge of MIL STDS & SPECS.

Engineers with a minimum of 5 years experience are encouraged to respond. To learn more about projects and career opportunities at Goodyear Aerospace, send your resume or a detailed letter of interest to: **Mr. K. Brott, GOODYEAR AEROSPACE, Mail Drop 4213, Dept. EDN0686, P.O. Box 85, Litchfield Park, AZ 85340.** Equal Opportunity Employer. U.S. Citizenship Required.

Arizona

GOODYEAR AEROSPACE

Meet Pat, Ray, Mark, Nancy, David, Charles, Hoon, and Jack, all engineers. Each of them has a different reason for being satisfied at Sedco. In their own words, they relate how Sedco fulfills their career expectations, as it fulfills those of the hundreds of other professional men and women employed here. As it can fulfill yours.

Minds Over Matter

"Sedco fits my specialties. Being a leader in ECM, Sedco gives me the opportunities to participate in systems development utilizing advanced technology. What I like most is working on something new. Something never done before. Something for the future. This makes my job more challenging."

DR. HOON, a Sr. Design & Development Engineer in Advanced Systems

"At Sedco, an individual can still make a big difference. Unlike large organizations where you're lost in the shuffle, here, if you have the will and ambition to do something positive, you can make an impact. There's no question about it!"

RAY, a Sr. Manufacturing Engineer (right)

"What makes Sedco different is the constant challenge it offers. You're never in a rut. You're involved in the state-of-art of Microwaves."

MARK, an Industrial Engineer (left)

"I came to Sedco four years ago because advancement opportunities seemed much better at Sedco than the company I was with. This has proven to be true."

JACK, a Section Manager in Microwave Engineering

"We are well taken care of. Sedco offers big company benefits since it's a part of Raytheon. But it's also small enough for one to get personal recognition, and that's what I'm looking for."

DAVID, an Associate Test Engineer

"I work in and manage the Advanced Systems group and enjoy the freedom to readily go after the ideas I want to pursue. I also enjoy the liaison work that takes place with many of our customers. But most of all, I enjoy the freedom I have which gives me a sense of growth. I still feel that there is considerable growth potential here for both myself and the other members in my group."

CHARLES, a Manager of Advanced Systems

"I am learning about phased array antennas. Not just testing and taking data, but learning how and why they work. We have the freedom to develop new test methods; to use our own methods and not someone else's. I also work on more extensive projects than I had expected."

PAT, an Associate TPS Engineer (left)

"Management is young and flexible. They like our input on what can be done for the betterment of the department. We count here."

NANCY, a Software Engineer TPS (right)

To work for Sedco, you must be a U.S. citizen, with a degree and directly applicable and current experience with a military-oriented and advanced electronics company. Above all, you must be determined to build your own individual record of achievement.

Apply your mind over matter in:

R&D Engineering

- Advanced Systems
- TPS (Test Program Sets)
- Microwave
- Project

Administrative/Manufacturing Support

- Finance
- Production Control
- Program Management

Support Engineering

- Test Engineering
- Quality Assurance/Quality Control
- Systems Support
- ILS/Field Service
- Industrial Engineering
- Data Management

You'll enjoy many rewards at Sedco. One of the best we offer is our benefits plan. We developed it with your present needs and future security in mind. In most cases, your family is also covered. Unless specified, your benefits are free and they apply on your first day at Sedco.

Please send detailed resume, indicating salary requirements and position applied for, to: **Sedco Systems, Personnel Dept. EDN6. 65 Marcus Drive, Melville, NY 11747.**

Sedco

A **Raytheon** Company

U.S. Citizenship required
An equal opportunity employer, M/F/V/H

MIND+POWER

It's that special combination of intellect and intensity that sets you apart from your peers and drives you toward new frontiers of technology.

At Garrett Turbine Engine Company in Phoenix, Arizona, we're challenging today's technology daily in the areas of aerodynamics, metallic/non-metallic materials, ceramics, instrumentation and control systems. And our continuing investment in—and commitment to—research and development means you can break through what **is** into exciting new arenas of turbine technology. We have unique challenges for aerospace professionals with experience in these areas.

AEROSPACE/TURBO MACHINERY OPPORTUNITIES

Engineering Design & Test

- Systems Analysis & Performance
- Non-Destructive Testing
- Engine Installation
- Cycle Analysis
- Computer Systems
- Power Systems & Electronic Controls
- Laboratory Test Facilities
- Maintainability
- Reliability
- Instrumentation
- Controls and Accessories

Manufacturing

- Machine Design
- Machining Design
- CAM Software Support
- Laser Machining Development
- Production, Methods & Measurements
- Factory Mod. Design & Systems

Quality Assurance

- Procurement
- NDT Specialists
- Field-Supplier Sites
- Engineering/Manufacturing

At Garrett, we provide you with the leading-edge equipment and the creative, professional atmosphere that let you take advantage of your greatest resource: Mindpower.

In return for your expertise, Garrett offers an excellent salary and benefits package. If you qualify, and if you're interested in a challenging future, send your resume and salary history in confidence to: R. Kloster, Employment, Garrett Turbine Engine Company, P.O. Box 5217, EDN786-RK, Phoenix, Arizona 85010.

An equal opportunity employer M/F/H.

GARRETT

ENGINEERS AND PROGRAMMERS:

SPERRY IN RESTON, VA

For more than 75 years, Sperry has focused its energy on one quest: meeting the demands of a changing world.

In meeting these needs, we have become one of the most respected names in high technology electronics and a leading supplier of advanced electronic warfare, ship communication/navigation, automated warehousing, and simulation systems. We're proud of our continuing success in providing high-quality innovative solutions through technology.

We're looking for mid- and senior-level engineers and programmers skilled in the following areas and programs who share this commitment with us:

- **Electronic Warfare**
- **TRIDENT II**
- **TRIDENT Trainer**
- **Automated Warehousing**
- **Shipboard Combat Information**
- **Shipboard Communications/ Navigation Systems**
- **Logistics Support Analysis**
- **Simulation Systems**

Sperry offers imaginative professionals important participation in all of these programs. Immediate assignments are available for individuals with a BS, or advanced degree in Electrical Engineering, Systems Science, Computer Science, Physics or Mathematics and at least 3-7 years experience.

PASCAL EXPERTISE NEEDED

We are particularly interested in seasoned professionals with experience in real-time energy applications to large-scale program development including PPS, design, coding, checkout, and documentation; SEL 32/27 and its software operating systems; Sperry-1100 equipment; and high order language programming, preferably Pascal, including design reviews, test, and evaluation of digital computer program performance.

In addition, **Sperry's Corporate Technology Center in Reston** is the site of advanced research in AI and signal processing. This is a creative research environment devoted to the exploration of many intriguing areas such as knowledge representation and acquisition, reasoning, natural language, distributed problem solving, and parallel algorithms and architectures, with applications in expert and knowledge-based systems, intelligent interfaces, data and information management, and AI development tools.

Sperry in Reston offers all the advantages of a fast-paced, high-tech environment. Only 18 miles from Washington, D.C., Reston offers easy access to the sophistication and excitement of our nation's capital . . . as well as the beauty of nearby Shenandoah Valley and Blue Ridge Mountains.

The Sperry Corporation provides the compensation and benefits package you would expect of a Fortune 100 Company: medical coverage including a dental plan, life insurance, a retirement plan, tuition assistance, in-house education, and more. Please send your resume in complete confidence to: **SPERRY CORPORATION, SYSTEMS MANAGEMENT GROUP,** 12010 Sunrise Valley Drive, Dept. EDN515, Reston, VA 22091. (703) 620-7000.

An equal opportunity employer, M/F/H/V. U.S. citizenship required.

SPERRY

© Sperry Corporation 1986

"Who the heck wants to hear actors talk?"

Harry M. Warner
Warner Bros. Pictures, c. 1927

The future isn't what it used to be.

There's no future in trying to stop the march of progress. That's especially true when it comes to the science of communication. If it had been left to Harry M. Warner, we would still be watching silent films. Fortunately, there are people who know that the future lies in leading the way, tackling the impossible, and making things happen.

They are at a company called TRW.

And when you join us at our Command Support Division in suburban Washington, D.C., you'll be encouraged to use your most creative ideas to find new solutions to new problems.

You'll be working on some of the most challenging projects of our times, on major programs in areas like Command, Control, and Communications Systems, Mobile C^3, Fixed Command Centers, Service Security, and Anti-Terrorism. Our continuing expansion in this defense-related business has created a continuing need for innovative individuals with C^3 experience. Specific areas of opportunity include:

COMMUNICATIONS SYSTEMS DESIGN ENGINEERS

Requires working knowledge of fiber-optics, RF systems, land-line communications, voice systems, and data communications engineering. You should also have experience with HF digitally-controlled equipment including power amplifiers, and antennas, computer hardware configuration, LANs, DEC VAX computers, telephone switches, data modems, and other peripherals.

ADP ENGINEERS

You will have experience designing communication software along with system and application software for state-of-the-art C^3I systems design, graphics and display, and MMI.

We have many positions available for both Senior Staff Engineers with ten years' experience and for Technical Staff Members (MTS) with 3-5 years experience.

All positions require a Bachelors degree in Electronics Engineering, Computer Engineering, Computer Science, or Systems Engineering.

We're committed to the Washington area and we've show it with the construction of our new complex in Fairfax County scheduled for occupancy, beginning in 1987. We're committed to your career growth and we show it with a professional environment unsurpassed in the industry and a truly superior compensation and benefits package.

If you'd like to make things happen, send your resume to: TRW Command Support Division, Attn: Dane Smith, Suite 400, Dept. ED7, 5111 Leesburg Pike, Falls Church, VA 22041.

TRW

A Company Called TRW

An Equal Opportunity Employer
U.S. Citizenship Required
Positions may require a background investigation

SYSTEMS & SOFTWARE ENGINEERS

Data Management Systems

At Eaton Corporation in Westlake Village we're looking for that "spark." The spark of innovative thinking that goes beyond today's technology and into tomorrow's. Right now we're looking for Systems and Software Engineers to add to a staff responsible for the design, implementation, integration, installation and support of Data Management Systems primarily for the Intelligence Community. Eaton is currently anticipating the award of a major contract to develop a large data base management system incorporating VAX clusters, LAN, communications and interactive terminal technology.

Successful **Systems Engineering** candidates must have experience with:

- Preparing requirements and Systems Design Documents
- Technical writing to Military Standards
- Military Data Base Management Systems
- Design, implementation and integration of Software Intensive Systems

Positions require a minimum of 8 years experience plus BSCS, BSEE or equivalent.

Successful **Software Engineering** candidates must have experience with:

- *VAX/VMS
- FORTRAN
- Data Base Management Systems
- Terminal Display Systems
- Software Development according to Military Standards

Positions require a minimum of 5 years experience plus BSCS or equivalent.

Eaton offers excellent starting salaries and superb benefits that include full medical and dental and a 401 (K) investment program. **RELOCATION PROGRAM AVAILABLE.**

If you would like to be a part of a successful team and meet the above requirements, please send resume to: **E.N. Smith, Manager, APPLICANTS ONLY, U.S. CITIZENSHIP REQUIRED. Eaton Corporation, 31717 La Tienda Drive, Box 5009, Westlake Village, California 91359.** An Equal Opportunity Employer.

*VAX/VMS are trademarks of Digital Equipment Corp.

EATON

SENCORE

JOIN THE HIGH ENERGY SENCORE ENGINEERING TEAM

Sencore designs, manufactures and markets a complete line of electronic test equipment used primarily to repair consumer goods worldwide. Increased demand in the marketplace means continued growth for us and opportunity for you.

SALES ENGINEERS

These inside sales positions require aggressive telemarketers with a degree in electronics. We provide qualified leads and extensive product training. Salary range is $20-35,000 with incentives.

PRODUCTION ENGINEERING MANAGER

This high visibility position requires an IE degree plus a minimum 5 years production engineering experience (supervisory background preferred). Responsibilities include supervising activities involving product testing, assembly and establishment of time standards.

QUALITY CONTROL MANAGER

An Associate degree in electronics is required. BSET or BSEE is preferred and 2-5 years Quality Control experience is considered a plus. Position is responsible for supervising technical staff in product design and manufacturing.

TEST EQUIPMENT DESIGN ENGINEER

An Associate degree in electronics or a BSET or BSEE (preferred) plus 2 years analog/digital, RF design and microprocessor experience required. Candidate should possess proven product design abilities and be able to translate customer needs into cost effective products.

Sencore operations are headquartered in Sioux Falls, S.D., a community of 100,000 featuring a quality of life that's second to none. Investigate these excellent opportunities affording state-of-the-art technology and outstanding benefits by submitting your resume or letter detailing qualification to: **Human Resources Department (EDN), SENCORE, INC., 3200 Sencore Drive, Sioux Falls, SD 57107.**

An Equal Opportunity Employer M/F.

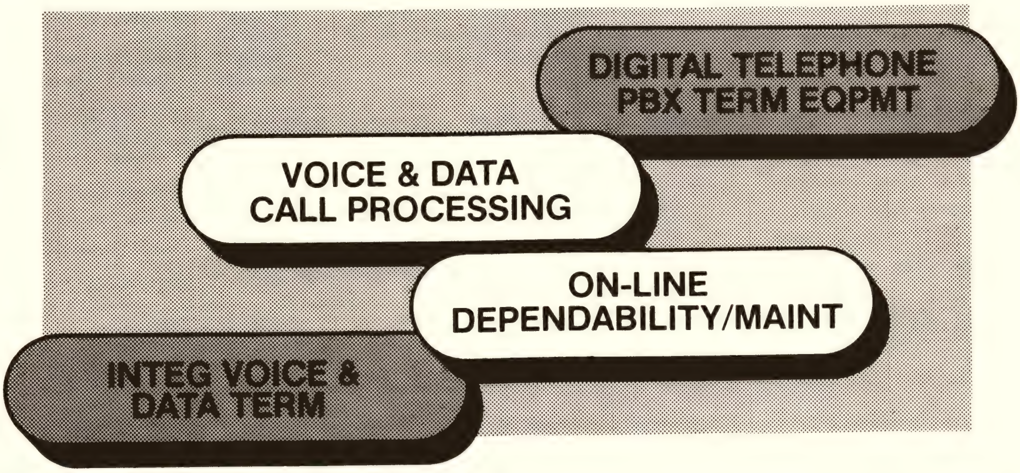
Reduced Recruitment Rates!

EDN

Place equivalent space in both EDN Career Opportunities and EDN Career News in the same month and get a ⅓ discount off the Career News rate.

SIEMENS

Siemens introduces exciting career paths in office automation


DIGITAL TELEPHONE PBX TERM EQPMT
VOICE & DATA CALL PROCESSING
ON-LINE DEPENDABILITY/MAINT
INTEG VOICE & DATA TERM

As part of a company recognized around the world as a high technology leader, Siemens Information Systems can make your future brighter in sunny Boca Raton, Florida.

Our communications systems link computers, workstations, printers, facsimile equipment and other systems into a single, integrated network. Siemens Information Systems plays a key role in the office automation revolution...but only with the help of talented men and women. Consider your future with us in one of the following openings:

Voice & Data Call Processing Software

Real-time Engineers needed to generate detailed specifications, code and test within the call processing software area. Minimum 2 years telephony experience required.

On-Line Dependability/Maintenance Software

Real-time Engineers with 3-5 years telephony experience needed for generation of detailed specifications, coding and testing within the call processing software area.

In addition to a popular resort climate, Florida offers affordable housing, low taxes and fine schools. Siemens can offer a competitive salary, advancement potential, and benefits that include generous relocation assistance. Take up the Siemens challenge by sending your resume to: Glenn Ogden, **Siemens Information Systems, Inc.,** Department 381694, 5500 Broken Sound Boulevard, N.W., Boca Raton, Florida 33431. Equal Opportunity Employer M/F/V/H.

Siemens...
where all paths lead to a great future.

EDN Databank

Professional Profile

Announcing a new placement service for professional engineers!

To help you advance your career. Placement Services, Ltd. has formed the EDN Databank. What is the Databank? It is a computerized system of matching qualified candidates with positions that meet the applicant's professional needs and desires. What are the advantages of this new service?

- **It's absolutely free. There are no fees or charges.**
- **The computer never forgets. When your type of job comes up, it remembers you're qualified.**
- **Service is nationwide. You'll be considered for openings across the U.S. by PSL and it's affiliated offices.**
- **Your identity is protected. Your resume is carefully screened to be sure it will not be sent to your company or parent organization.**
- **Your background and career objectives will periodically be reviewed with you by a PSL professional placement person.**

We hope you're happy in your current position. At the same time, chances are there is an ideal job you'd prefer if you knew about it.

That's why it makes sense for you to register with the EDN Databank. To do so, just mail the completed form below, along with a copy of your resume, to: Placement Services, Ltd., Inc.

IDENTITY

Name ____________________

Home Address: ____________________

City ____________ State: ________ Zip: ________

Home Phone (include area code): ____________________

PRESENT OR MOST RECENT EMPLOYER

Parent Company ____________________

Your division or subsidiary: ____________________

Location (City, State) ____________________

Business Phone if O.K. to use: ____________________

EDUCATION

Degrees (List)	Major Field	GPA	Year Degree Earned	College or University

POSITION DESIRED

____

EXPERIENCE

Present or Most Recent Position From: To: Title:

Duties and Accomplishments: Industry of Current Employer:

____

____

____

____

Reason for Change: ____________________

PREVIOUS POSITION:

Job Title: ____________________

Employer: ____________ From: ______ To: ______ City: ____________ State: ____________

Division: ____________ Type of Industry: ____________ Salary: ____________

Duties and Accomplishments: ____________________

COMPENSATION/PERSONAL INFORMATION

Years Experience	Base Salary	Commission	Bonus	Total Compensation	Asking Compensation	Min. Compensation

Date Available	I Will Travel ☐ Light ☐ Moderate ☐ Heavy	☐ I own my home. How long? ________ I rent my home/apt. ☐
☐ Employed ☐ Self-Employed ☐ Unemployed	☐ Married ☐ Single	Height ________ Weight ________
Level of Security Clearance	☐ U.S. Citizen ☐ Non-U.S. Citizen	My identity may be released to: ☐ Any employer ☐ All but present employer

☐ WILL RELOCATE ☐ WILL NOT RELOCATE ☐ OTHER ____________

EDN Databank

A DIVISION OF PLACEMENT SERVICES LTD., INC.

265 S. Main Street, Akron, OH 44308 216/762-0279

ADVERTISERS INDEX

Additive Products Div, Kollmorgan Corp . . . 255
AIE Magnetics . . . 269
Airpax Corp/Frederick Div . . . 267
Altera Corp . . . 34-35
AMP Inc . . . 128-129
Amphenol Products, An Allied Co . . . 14-15
Anaheim Automation . . . 192
Analog Design Tools . . . 149
Analog Devices Inc . . . 236-237, 239, 241, 243, 245
Ando Electric Co Ltd . . . 184
Aptos Systems Corp . . . 143
Arrow Electronics . . . 145
AT&T Technologies . . . 39, 40-41
Autodesk Inc . . . 63
Behlman Engineering Corp . . . 222
Belden Electronic Wire & Cable . . . C4
Benson Inc . . . 199
Boeing Electronics Co . . . 251, 253
B V Engineering . . . 271
Caddock Electronics Inc . . . 249
Cahners Exposition Group . . . 152
Calcomp . . . 268
California Scientific Software . . . 270
Calmos Systems Inc . . . 258
Canadian Thermostats & Control Devices Ltd . . . 272
Carroll Touch Inc . . . 98
Case Technology . . . 12-13
Catalyst Semiconductors Inc . . . 38
Century Cad Systems . . . 119
Cermetek Microelectronics Inc . . . 271
C&K Components Inc . . . 6
Compcontrol . . . 261
Computer Products Inc, Grant Technology Div . . . 275
The Cooper Group* . . . 103
Crystek Corp . . . 271
CTS Corp . . . 197
Cybernetic Micro Systems . . . 62,272
Cypress Semiconductor . . . 84-85
Daisy Systems Corp . . . 168
Dallas Semiconductor . . . 106
D A T A Inc . . . 240
Digelec Inc . . . 269
Digital Equipment Corp* . . . 166-167
DY-4 Systems Inc . . . 270
EIE Electronic Industrial Equipment** . . . 127
Elcon Products International Co . . . 269
Electronic Modular Systems Inc . . . 279
Epoxy Technology Inc . . . 120
Equipto Electronics Corp . . . 156
E-T-A Circuit Breakers . . . 270
Exar Corp . . . 68-69
Factron Schlumberger** . . . 262-263
Fairchild Memory and High Speed Logic . . . 26-27
Ferranti Interdesign Inc . . . 57
Force Computers Inc . . . 28-29
Fujitsu America Inc/ Storage Products . . . 264-265
FutureNet/Div of Data I/O . . . 64-65
General Electric Plastics . . . 50
General Electric Semiconductor Products . . . 46-47
Generic Software . . . 272
Gould AMI Semiconductors* . . . 48-49
Grayhill Inc . . . 118
Hall-Mark . . . 229
Harris Custom Integrated Circuits Div . . . 86
Heurikon Corp . . . 248
Hewlett-Packard Co . . . 79
Hitachi America Ltd* . . . 180-182
Honeywell Digital Products Center . . . 192
Honeywell Test Instrument Div . . . 95
Houston Instrument . . . 117
Hughes Aircraft Co . . . 257
I-Bus Systems . . . 102
IC Master* . . . 113
ILC Industries Inc . . . 276
Inmos Corp . . . 10-11
Inresco . . . 270, 272
Intech Microcircuits . . . 94
Integrated Device Technology Inc . . . 91
Intel Corp . . . 96-97, 210-211
International Microcircuits Inc . . . 52
Introl Corp . . . 271
Intusoft . . . 209
John Fluke Manufacturing Co Inc . . . 175, 272
Kepco Inc . . . 203-208
KMW Systems Corp . . . 147
Laserpath . . . 242
Linear Technology Corp . . . 224
Logical Systems Corp . . . 271
Lundy Electronics and Systems Inc . . . 163
Measurement Systems Inc . . . 275
Mentor Graphics Corp . . . 130-131
Micro Power Systems . . . 81
Mini-Circuits Laboratories . . . 3, 4, 24-25, 227
Molex Inc . . . 296
Monolithic Memories Inc . . . C2
Murata Erie North America Inc . . . 72
NCR Microelectronics Div . . . 21
NEC Corp . . . 164-165
NEC Electronics Europe** . . . 180-181
Nicolet Computer Graphics . . . 99
Nicolet Oscilloscope Div . . . 23
Oasys/Div of XEL . . . 244
Oki Semiconductor* . . . 105
Omation Inc . . . 269
Omnibyte Corp . . . 88
OrCAD Systems Corp . . . 272
Orcatech Inc . . . 59
PEP . . . 42-43
Performance Interconnect Inc . . . 107
Personal CAD Systems Inc . . . 234-235
Philips Elcoma Div** . . . 82-83, 166-167
Philips Test & Measuring Instruments Inc . . . 231
Plessey Microsystems . . . 115
Plessey Microsystems Ltd . . . 100
Plessey Semiconductor . . . 16-17
Potter & Brumfield . . . 179
Power General . . . 111
Powerex Inc . . . 177
Precision Monolithics Inc . . . 109
Pro-Log Corp . . . 70
Qua Tech Inc . . . 270
Raytheon Semiconductor Div . . . 55
Rogers Corp . . . 271
Samsung Semiconductor . . . 44
SBE Inc . . . 212
Semiconductor Circuits, Div of Powertec . . . 98A-D
Severe Environment Systems Co . . . 259
Siemens AG** . . . 103, 105, 113, 182-183
Siemens Corp* . . . 127
Signetics Corp* . . . 82-83
Silicon Systems Inc . . . 60, 61
Simucad . . . 195
Sohio Engineered Materials Co . . . 201
Solitron Devices Inc . . . 36
Spectrum Software . . . 37
Sprague Electric Co . . . 31, 75, 270
Sprague-Goodman Electronics Inc . . . 271
Stag Microsystems Inc . . . 18
Sunrise Electronics . . . 80
TDK Corp . . . 178
Tektronix Inc . . . 8, 32-33
Tektronix-CAE Systems Div . . . 191, 193
Teledyne Gurley . . . 274
Teledyne Relays . . . 232
Teledyne Solid State . . . 269
Telesis . . . 246
Thomson Semiconductors** . . . 48-49
Todd Products . . . 77
Tusonix Inc . . . 30
Uniform Tubes Inc . . . 252
Universal Data Systems . . . C3
Valid Logic Systems Inc . . . 153-155
Versatec, A Xerox Co . . . 66-67
Vicor Corp . . . 121
Viewlogic . . . 132-133
Visionics Corp . . . 247
VLSI Technology Inc . . . 122-123
WC Heraus** . . . 256A-B
Western Digital Corp . . . 124-125
Whitesmiths Ltd . . . 294
WinSystems Inc . . . 269
Wintek Corp . . . 223, 270
Xilinx Inc . . . 150-151
Zilog Inc . . . 93
Ziltek Corp . . . 275

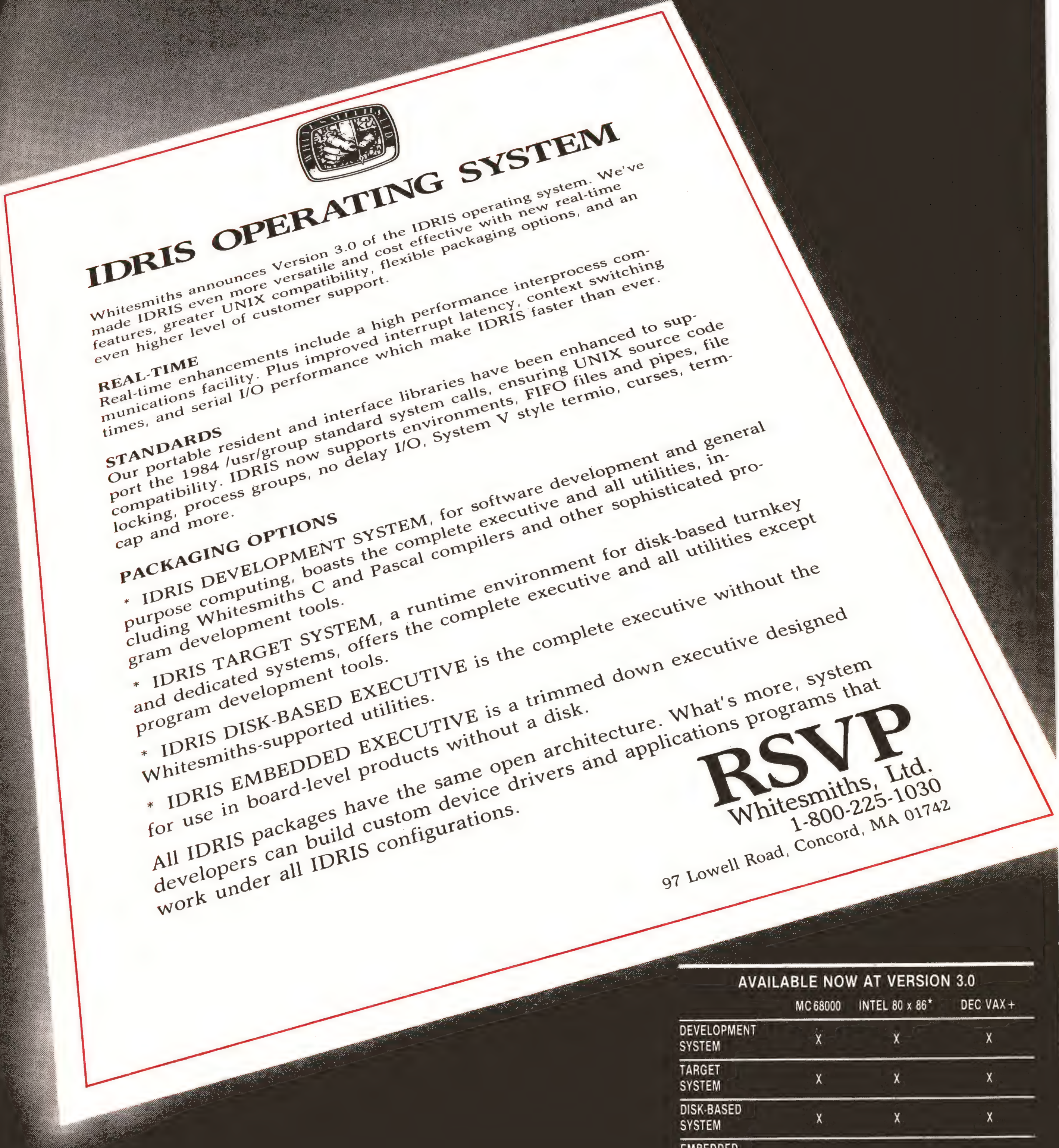
Recruitment Advertising

Cipher Data . . . 282
Comarco Weapons Support Division . . . 280
Computer Science and Engineering . . . 282
Eaton Corp . . . 290
Garrett Turbine Engine Company . . . 287
General Dynamics Data Systems . . . 283
Goodyear Aerospace . . . 285
Grumman Aerospace . . . 281
Intel . . . 284
MTI . . . 282
Sedco Systems . . . 286
Sencore . . . 290
Siemens Information Systems . . . 291
Sperry Systems Management Group . . . 288
TRW Command Support Division . . . 289
Wallach Associates . . . 286
Zenith Data Systems . . . 280

*Advertiser in US edition
**Advertiser in International edition

This index is provided as an additional service. The publisher does not assume any liability for errors or omissions.

An Invitation To Meet The IDRIS Team



IDRIS OPERATING SYSTEM

Whitesmiths announces Version 3.0 of the IDRIS operating system. We've made IDRIS even more versatile and cost effective with new real-time features, greater UNIX compatibility, flexible packaging options, and an even higher level of customer support.

REAL-TIME
Real-time enhancements include a high performance interprocess communications facility. Plus improved interrupt latency, context switching times, and serial I/O performance which make IDRIS faster than ever.

STANDARDS
Our portable resident and interface libraries have been enhanced to support the 1984 /usr/group standard system calls, ensuring UNIX source code compatibility. IDRIS now supports environments, FIFO files and pipes, file locking, process groups, no delay I/O, System V style termio, curses, termcap and more.

PACKAGING OPTIONS

* IDRIS DEVELOPMENT SYSTEM, for software development and general purpose computing, boasts the complete executive and all utilities, including Whitesmiths C and Pascal compilers and other sophisticated program development tools.

* IDRIS TARGET SYSTEM, a runtime environment for disk-based turnkey and dedicated systems, offers the complete executive and all utilities except program development tools.

* IDRIS DISK-BASED EXECUTIVE is the complete executive without the Whitesmiths-supported utilities.

* IDRIS EMBEDDED EXECUTIVE is a trimmed down executive designed for use in board-level products without a disk.

All IDRIS packages have the same open architecture. What's more, system developers can build custom device drivers and applications programs that work under all IDRIS configurations.

RSVP
Whitesmiths, Ltd.
1-800-225-1030
97 Lowell Road, Concord, MA 01742

AVAILABLE NOW AT VERSION 3.0

	MC68000	INTEL 80 x 86*	DEC VAX+
DEVELOPMENT SYSTEM	X	X	X
TARGET SYSTEM	X	X	X
DISK-BASED SYSTEM	X	X	X
EMBEDDED EXECUTIVE	X		

* Cohabitates with DOS
+ Cohabitates with VMS

CIRCLE NO 164

LOOKING AHEAD

EDITED BY GEORGE STUBBS

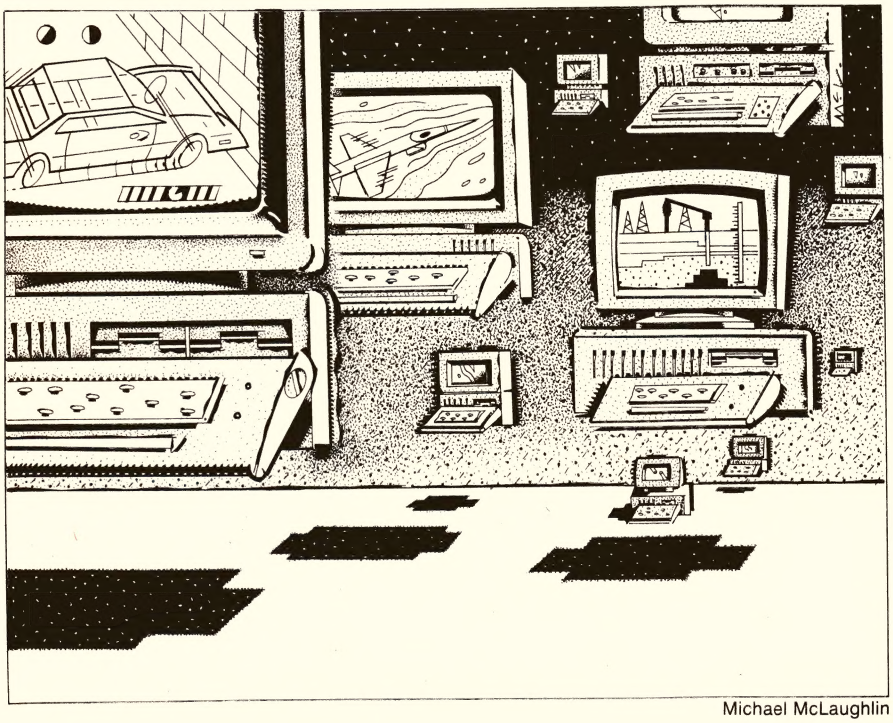
Supercomputer sites to grow by 60% annually through '90

Throughout the world, the number of supercomputer sites should grow from 129 at the end of 1985 to more than 1350 by the end of 1990, reports Sanford C Bernstein & Co Inc, a market-research company based in New York City. The growth rate is 60%, compounded annually, and covers installations at commercial, government, and university sites. The number of actual supercomputers installed throughout this period should total 1670.

Bernstein & Co defines the supercomputer as a machine capable of performing at least 100M flops. This characterization is common throughout the industry, even though new technologies—particularly developments in parallel processing—will soon result in commercially available machines that make 100M-flops vector processors look rather quaint by comparison. Bernstein & Co defines a commercial site as a "heavily computerized" facility with 100 or more engineers, scientists, and mathematicians. By 1990, 38% of the sites that meet this criterion should have supercomputers.

Supercomputers fulfill the demands of a wide variety of applications, from aeronautics, animation, and oil exploration to design and simulation in the development of many kinds of products. The high-speed machines cut the time of complex computations from years to hours and thus allow designers and scientists to simulate more thoroughly the behavior of systems in varying environments. Obviously, supercomputing power is very important to the growth of expert systems (EDN, July 11, 1985, pg 341).

The consequent shortened development cycles and the elimination of other costs—for example, crash tests of automobiles can be simulated by supercomputers—will prove very attractive to manufacturers. And once one supplier in an industry acquires a supercomputer, the others will neglect to do so at their peril; companies cannot afford to fall far behind in the introduction of new products.



Michael McLaughlin

Market for PC-based CAD grows despite limitations

Computer-aided design (CAD) on personal computers has grown from its humble origins as a computer-graphics toy into a multimillion-dollar business. According to the market-research company Technology & Business Communications Inc (Sudbury, MA), that growth will continue, transforming a $60 million 1984 market to a $1 billion market in 1990. The growth, says TBC, seems paradoxical at first glance, given the inherent limitations of designing on personal computers.

When used in a CAD application, a personal computer faces shortcomings of memory capacity, processing speed, and operating features. TBC sums up the problem: Most PC-based CAD systems conveniently handle drawings consisting of 2000 elements (lines, text strings, etc), while larger computers can handle drawings composed of 10,000 elements. What's more, says TBC, insufficient profit margins prevent vendors of PC-based CAD systems from giving much individual attention to customers.

In spite of these factors, the market grows, and the reasons are based on economics. You can turn the personal computer you already own into a CAD system for as little as $1000, and you can purchase a basic system—PC, peripherals, software, etc—for no more than $10,000. The amortization of such an investment compares favorably with the cost of engineering time, which is $15 to $25 an hour, according to TBC. The time it takes to pay back the original investment, says TBC, is less than one year.

Other benefits of PC-based CAD are the ease with which you can learn to operate the systems, and the ready availability of software and peripherals. Also, a PC-based facility is not dedicated to CAD; a PC handles other tasks as well.

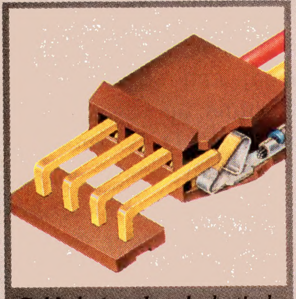
Molex Is Making The Connection Between…

FLEXIBILITY & RELIABILITY

Intensive QC programs provide reliable connectors that stand up to tough environmental conditions in a wide range of electronic applications.

Eleven different components are your building blocks for thousands of interconnection solutions.

Molex's unique family of KK® connectors provide the flexibility you need to build interconnections precisely suited to your applications. Choose either tin or cost-effective selective gold plating, .100″ or .156″ center spacing. Crimp, solder, or insulation displacement termination…top, side, or bottom pin entry…break-to-size pin headers…they're all standard in thousands of demanding applications.



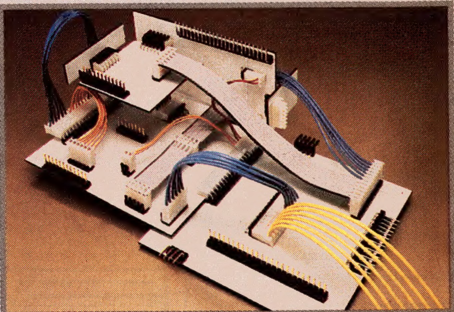
Gold plating placed selectively on terminal contact points means added economy.

The KK® connector is just one example of how we take a total systems approach.

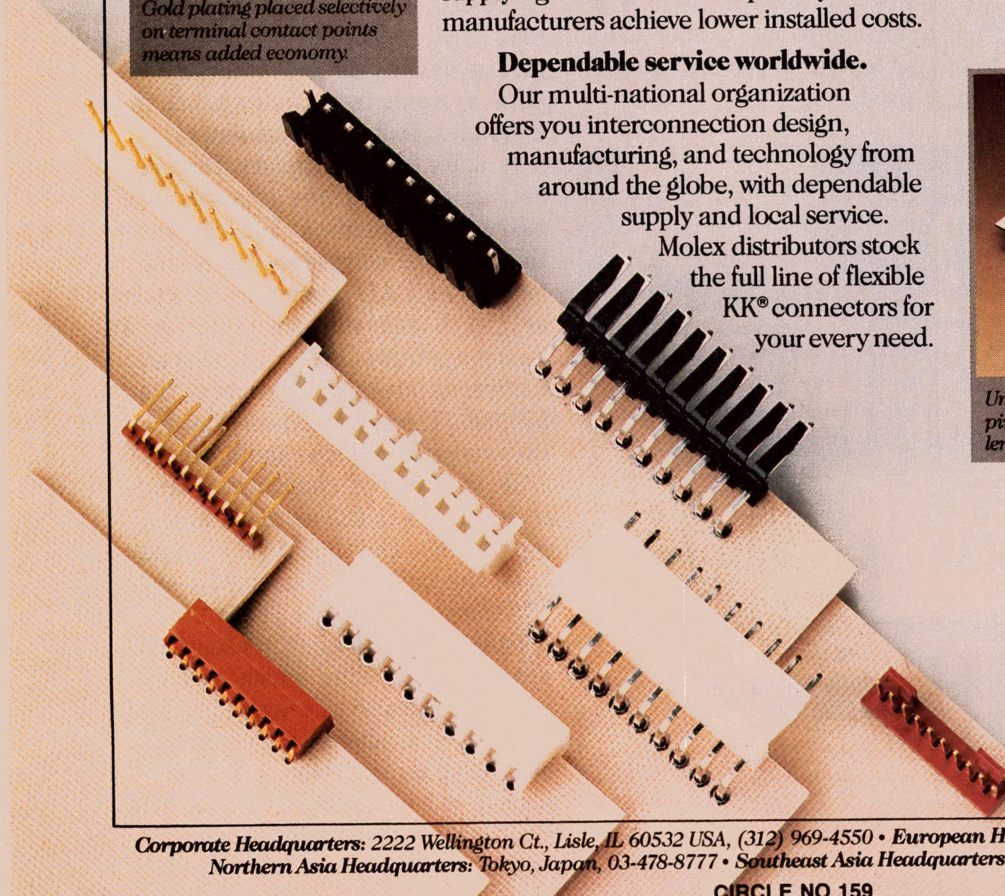
The KK® System includes a complete line of wire termination tooling from simple hand crimp tools to the latest automated insulation displacement technology. The System also features sophisticated pinsetting equipment. Molex goes beyond merely supplying connectors to help today's manufacturers achieve lower installed costs.

Dependable service worldwide.

Our multi-national organization offers you interconnection design, manufacturing, and technology from around the globe, with dependable supply and local service. Molex distributors stock the full line of flexible KK® connectors for your every need.



Unique break-away design allows you to order pin headers in bulk and break off the exact lengths you need to save on inventory and waste.



molex®

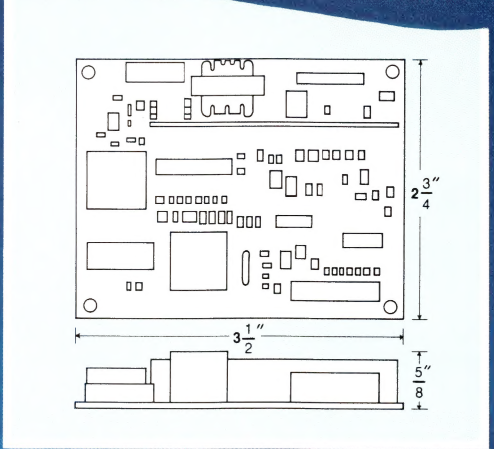
Service To The Customer…Worldwide

Corporate Headquarters: *2222 Wellington Ct., Lisle, IL 60532 USA, (312) 969-4550 •* ***European Headquarters:*** *Aldershot, England, (0252)318221*
Northern Asia Headquarters: *Tokyo, Japan, 03-478-8777 •* ***Southeast Asia Headquarters:*** *Jurong Town, Singapore, 65-261-9733*

CIRCLE NO 159

MODEM DESIGN ELEGANCE IS SURFACE DEEP

ACTUAL SIZE



A FULLY FEATURED 212A ON 9.6 SQ. IN.

At Universal Data Systems, surface-mount technology has brought a new level of engineering elegance to 212A modem design. Using a combination of LSI and surface mounting techniques, we're now able to fit a *fully featured* 212A on just 9.6 square inches of board space.

And when we say fully featured, we *mean* fully featured. Requiring only +5V to operate, this superminiature device has the same auto-dial, auto-answer, audio driver, line diagnostic and self-test features formerly found only on larger, heavier, more power-hungry and more expensive 212As.

It's available now in a standard configuration, ready for internal mounting in the new terminal, microcomputer or other data communications device you're designing.

Others may be claiming smaller 212As. But, to be sure you're getting a true fully featured device at a most attractive price, contact UDS for detailed specifications. Universal Data Systems, 5000 Bradford Drive, Huntsville, AL 35805. Telephone **205/721-8000**; Telex 752602 UDS HTV.

Universal Data Systems

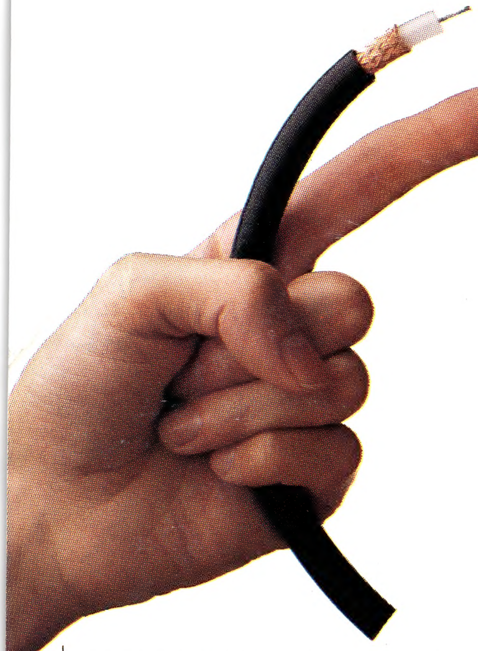
MOTOROLA INC.
Information Systems Group

UDS modems are offered nationally by leading distributors. Call the nearest UDS office for distributor listings in your area.

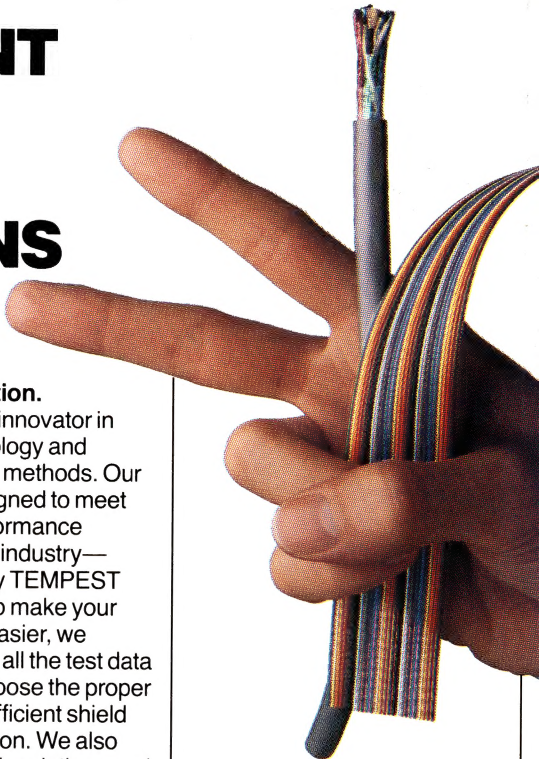
DISTRICT OFFICES: **Atlanta,** GA, 404/998-2715 • **Aurora,** CO, 303/368-9000 • **Blue Bell,** PA, 215/643-2336 • **Boston,** MA, 617/875-8868 • **Columbus,** OH, 614/895-3025 • **East Brunswick,** NJ, 201/238-1515 • **Glenview,** IL, 312/998-8180 • **Houston,** TX, 713/988-5506 • **Huntsville,** AL, 205/837-8100 • **Issaquah,** WA, 206/392-9600 • **Mesa,** AZ, 602/820-6611 • **Milwaukee,** WI, 414/273-8743 **Minnetonka,** MN, 612/938-9230 • **Mission Viejo,** CA, 714/770-4555 • **Mountain View,** CA, 415/969-3323 • **Richardson,** TX, 214/680-0002 • **St. Louis,** MO, 314/434-4919 • **Silver Spring,** MD, 301/942-8558 • **Tampa,** FL, 813/684-0615 • **Uniondale,** NY, 516/222-0918 • **Van Nuys,** CA, 818/890-3282 • **Willowdale,** Ont, Can, 416/495-0008 • **Ypsilanti,** MI, 313/483-2682

CIRCLE NO 171

Created by Dayner/Hall, Inc., Winter Park, Florida

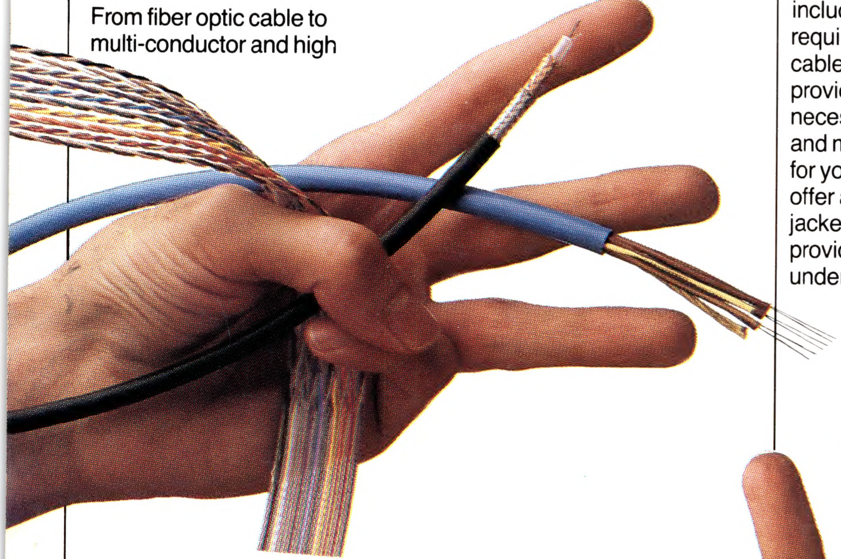


4 REASONS TO SPECIFY BELDEN FOR YOUR GOVERNMENT AND MILITARY APPLICATIONS



Selection. We offer a broad line of electronic wire and cable designed to meet military specifications such as MIL C 17, MIL C 49055, MIL W 16878, MIL W 22759 and others. Many are QPL listed.

From fiber optic cable to multi-conductor and high temperature cables, choose the cable best suited to your specific application. Or work with our Product Engineering Group to design specialty cable to your exact requirements.



Belden Innovation.
We're a leading innovator in shielding technology and patented testing methods. Our shielding is designed to meet the highest performance standards in the industry—including military TEMPEST requirements. To make your cable decision easier, we provide you with all the test data necessary to choose the proper and most cost-efficient shield for your application. We also offer a variety of insulations and jacketing materials designed to provide superior performance under hostile environmental conditions. Critical application requirements are not a problem when you work with Belden.

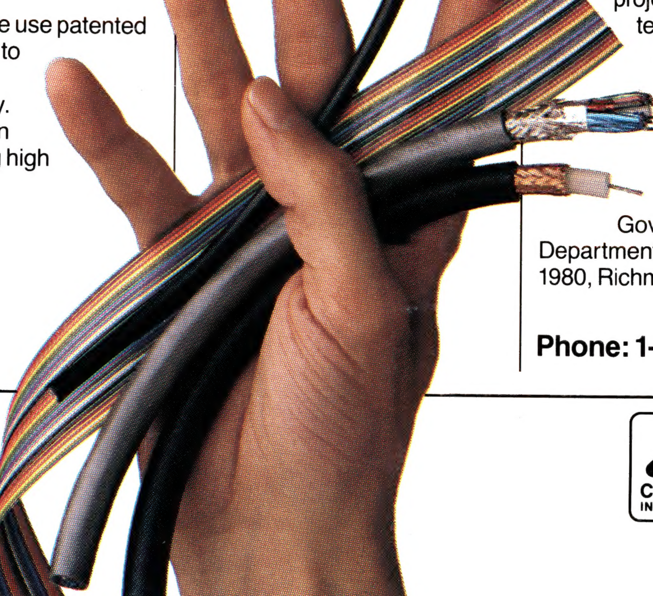
The Belden Government Department. Since we understand how the government and prime contractors work, we provide you with full support services—from sales and engineering support to contract administration. We're ready to help with your design decisions where and when you need us.

To make your design project easier, call us for technical assistance. Because when you specify Belden, There is no equal.

Contact the Belden Electronic Wire and Cable Government Department today. P.O. Box 1980, Richmond, IN 47375.

Phone: 1-800-BELDEN-4

Quality and Reliability.
After working with governmental and military applications for over 30 years, we understand the interrelationship of quality components and critical requirements. We believe quality is the responsibility of leadership. That's why our Quality Assurance Department has full authority to maintain high quality standards for our products. And we use patented testing methods to guarantee our product reliability. Choosing Belden means choosing high quality, reliable products.



There is no equal.™

Copyright © 1986 Cooper Industries, Inc.

CIRCLE NO 172

COOPER INDUSTRIES

BELDEN